OPEN SPACE DEVELOPMENT STRATEGY FOR IMPROVING QUALITY OF LIFE: A CASE OF BANGALORE CITY

Project Phase-II

submitted to

Visvesvaraya National Institute of Technology,
Nagpur in partial fulfillment of the requirements
for the award ofthe degree

MASTER OF TECHNOLOGY

IN

URBAN PLANNING

By

Jagruti Bajaj

(MT23UPL022)

under the guidance of

Dr.Vidya Ghuge

Department of Architecture and

Planning, Visvesvaraya National Institute

of TechnologyNagpur 440 010 (India)

Year 2024-2025

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Declaration

I, **Jagruti Bajaj**, hereby declare that this project titled **"Open Space Development Strategy for Improving Quality of Life: A Case of Bangalore City"** is carried out by me in the **Department of Architecture and Planning**, Visvesvaraya National Institute of Technology, Nagpur. The work is original and has not been submitted earlier whole or inpart for the award of any degree/diploma at this or any other Institution / University.

Jagruti Bajaj
Date:

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This to certify that this project titled "**Open Space Development Strategy for Improving Quality of Life: A Case of Bangalore City"** is submitted by **Jagruti Bajaj** in partial fulfillment of the requirements for the award of the degree of **Master of Technology in Urban Planning,** VNIT, Nagpur. The work is comprehensive, complete and fit for final evaluation.

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Date:

Department of Architecture and Planning.
Visvesvaraya National Institute of Technology,
Nagpur

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Thank you all for your support and encouragement.

-Jagruti Bajaj

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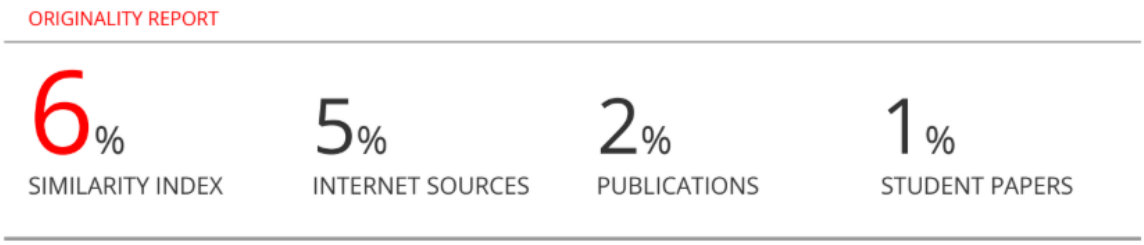

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ABSTRACT

This study examines how developing open spaces can improve the quality of life in Bangalore City, once celebrated as India's "Garden City." The city has experienced rapid urbanization and population growth, leading to a significant decrease in green areas from 68% in 1973 to a mere 25% by 2012 while the built-up regions have grown by over 170% in the past thirty years. Utilizing spatial analysis, remote sensing, and GIS methods, the research maps the distribution, accessibility, and capacity of parks and open spaces throughout the city. The results highlight a significant disparity: central Bangalore has relatively better access to organized green spaces, whereas peripheral areas and marginalized communities suffer from severe shortages, with some wards having no parks at all. Currently, open space availability is only 2.2 square meters per person, which is far below both national and international benchmarks. This shortfall has led to overcrowded and poorly maintained parks, worsening urban heat island effects, degrading air quality, and limiting opportunities for recreation and social interaction. The research identifies critical areas using satellite imagery and performs a demand-supply analysis based on population data. It also explores the connections between open spaces and physical, mental, and social well-being, emphasizing the urgent need for a strategic and equitable approach to open space planning. The study concludes with practical recommendations for improving the quantity, quality, and accessibility of open spaces, such as adopting the Green Equity Bangalore Model (GEBM), creating biodiversity parks on landfill sites, and integrating parks as climate action zones. These strategies aim to create a more inclusive, resilient, and sustainable urban environment, ensuring that all residents benefit from enhanced ecological health, social cohesion, and overall quality of life. The research emphasizes that revitalizing Bangalore’s open spaces is not just an environmental necessity but a fundamental aspect of sustainable urban development and human well-being.

Keywords:

Open Space Development, Quality of Life, Bangalore City, Urban Planning, Green Cover, Spatial Analysis, GIS, Green Equity Bangalore Model (GEBM), Biodiversity Parks

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1 INTRODUCTION:

1.1 Background Study:

Bangalore, once celebrated as the "Garden City of India," boasts a storied history of urban greenery, with renowned parks such as Cubbon Park and Lalbagh serving as crucial recreational, ecological, and cultural sites for many generations. However, the city's landscape has undergone significant changes in recent decades due to rapid and often haphazard urban development and a booming population. The green cover has dwindled from 68% in 1973 to a mere 25% by 2012, while the built-up area expanded by over 170% between 1985 and 2015. This shift has been fueled by the incorporation of nearby villages and municipalities into the larger Bangalore area, creating a vast metropolis with a population surpassing 12 million. Despite the Karnataka Parks, Play-Fields and Open Spaces (Preservation and Regulation) Act requiring that 15% of city land be allocated for open spaces, Bangalore currently provides only 2.2 square meters of open space per person, which is far below both national and international benchmarks. The repercussions are clear: overcrowded and poorly maintained parks, the disappearance of lakes and biodiversity, urban heat island effects, deteriorating air quality, and a marked reduction in residents' opportunities for recreation and social interaction. These issues are particularly severe in the city's outskirts and among marginalized groups, where access to organized green spaces is extremely limited. There is an urgent need for a strategic and equitable approach to developing open spaces, as they are crucial not only for physical and mental well-being, social cohesion, and environmental resilience but also for improving the overall quality of urban life. This research highlights the issues, with the objective of assessing the present condition of Bangalore's open areas, analyzing their distribution and accessibility, and proposing actionable measures to revitalize and improve the city's green legacy for all residents.

1.1.2 Introduction to Open Spaces

Open spaces have become a crucial element in urban management, significantly contributing to the vibrancy of cities. The presence and quality of open areas in Indian cities have been diminishing over time, requiring urgent action. This unit presents the definition and concept of open spaces, examines their historical planning, and evaluates their current state in Indian cities. It also highlights new global trends in open space development and the insights they provide.

Urban open areas are vital to city life, offering sites for recreation, community interaction, and ecological sustainability. The definition of open space has changed over time, influenced by various cultural and academic viewpoints from different nations.

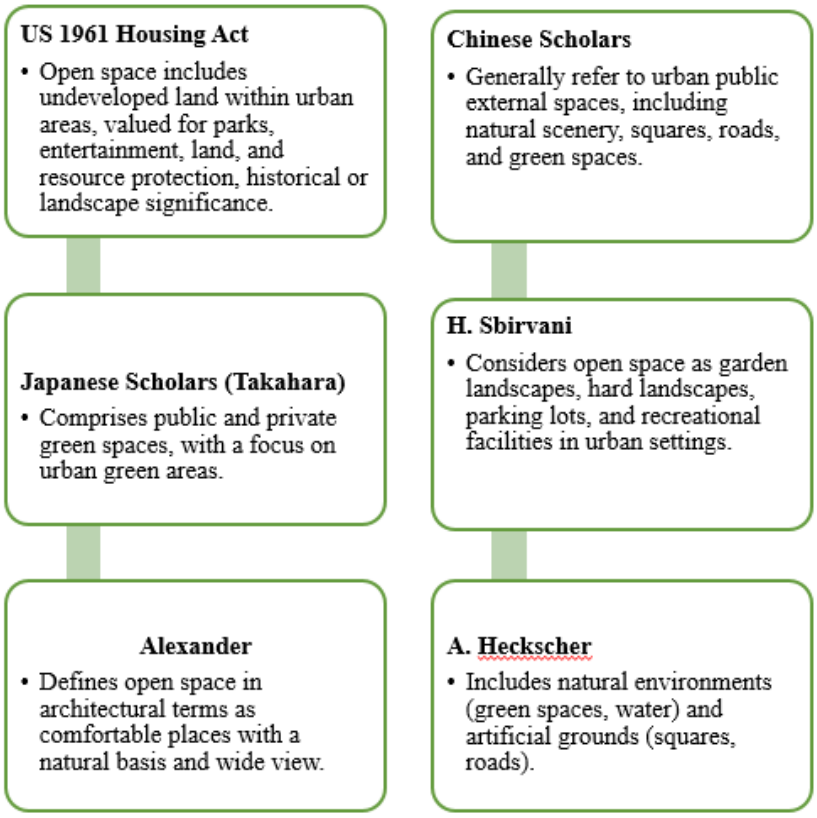

US 1961 Housing Act
• Open space includes undeveloped land within urban areas, valued for parks, entertainment, land, and resource protection, historical or landscape significance.
Chinese Scholars
• Generally refer to urban public external spaces, including natural scenery, squares, roads, and green spaces.
Japanese Scholars (Takahara)
• Comprises public and private green spaces, with a focus on urban green areas.
H. Sbirvani
• Considers open space as garden landscapes, hard landscapes, parking lots, and recreational facilities in urban settings.
Alexander
• Defines open space in architectural terms as comfortable places with a natural basis and wide view.
A. Heckscher
• Includes natural environments (green spaces, water) and artificial grounds (squares, roads).

Figure 1

Urban open space, as a complement to development, represents both a natural and cultural asset, and should not simply be equated with 'unused land' or solely 'park and recreation areas.' Additionally, open space refers to land or water territories that are exposed to the sky, intentionally acquired or governed by public regulations to fulfil conservation and urban design purposes, while also offering recreational opportunities.

The term open space was first applied in 1833 by a committee in a “public trail in London. Then another definition appears in “Metropolitan Open Space Act” made in London in Britain in 1877. Then in 1906, defined the open space as any land, less than 5% of which is occupied with buildings. (RAKHSHANDEHROO MEHHDI)

Open Space System in Urban Centers: Open space systems in urban centers are crucial for providing public activities, maintaining ecological balance, and enhancing the quality of life.

Open Space for Leisure:
Parks, green spaces, and areas for recreation
Open Space for Commerce:
Commercial pedestrian streets, squares for public interaction and business activities.
Open Space for Transportation:
Areas like station squares and traffic green islands, essential for traffic organization and landscape appreciation.

Figure 2

1.1.3 Introduction to Quality of Life

Quality of life is a multidimensional phenomenon composed of core dimensions influenced by personal characteristics and environmental factors. (Schalock)

A complex idea, quality of life has multiple important dimensions that are impacted by both environmental and personal variables.

It includes physical, mental, and social well-being, and can be shaped by factors such as housing, transportation, education, employment, and community conditions. Assessing the quality of life in urban areas has become increasingly important as cities grow and change. This involves examining the significance of evaluating quality of life at various urban scales, from state-level assessments to those focused on specific neighborhoods. The many metrics and techniques used to assess and enhance urban living conditions, as well as the connection between the built environment and quality of life will be assessed.

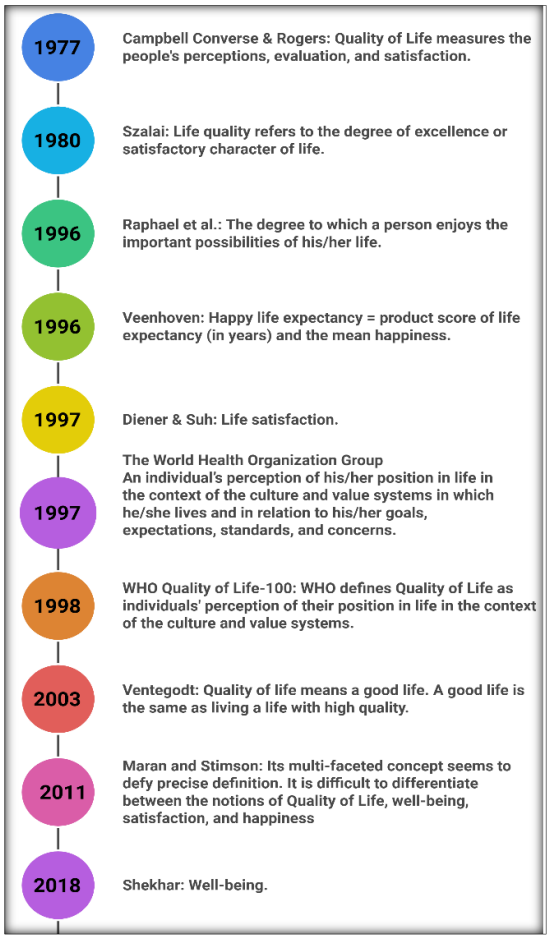

1977
Campbell Converse & Rogers: Quality of Life measures the people's perceptions, evaluation, and satisfaction.
1980
Szalai: Life quality refers to the degree of excellence or satisfactory character of life.
1996
Raphael et al.: The degree to which a person enjoys the important possibilities of his/her life.
1996
Veenhoven: Happy life expectancy = product score of life expectancy (in years) and the mean happiness.
1997
Diener & Suh: Life satisfaction.
1997
The World Health Organization Group
An individual's perception of his/her position in life in the context of the culture and value systems in which he/she lives and in relation to his/her goals, expectations, standards, and concerns.
1998
WHO Quality of Life-100: WHO defines Quality of Life as individuals' perception of their position in life in the context of the culture and value systems.
2003
Ventegodt: Quality of life means a good life. A good life is the same as living a life with high quality.
2011
Maran and Stimson: Its multi-faceted concept seems to defy precise definition. It is difficult to differentiate between the notions of Quality of Life, well-being, satisfaction, and happiness
2018
Shekhar: Well-being.

Figure 3

1.1.4 Challenges and Problems in Bangalore City

Rapid urbanization has caused Bangalore, which was formerly hailed as the "Garden City of India," to undergo a significant metamorphosis in recent decades.
Significant demographic shifts have resulted from Bengaluru's urban agglomeration, which consists of the Bengaluru urban district, Bengaluru rural district, and Ramanagar a district, experiencing fast urbanization and population expansion.
Poorer populations were left without proper housing or access to open spaces as a result of these initiatives, which mostly benefited the middle and upper classes.
As Bangalore developed as a significant urban hub, the shortcomings of open spaces be came more apparent.
About 8.4% of the city's land is set aside for green space, which is not enough for the more than 12 million people who call it home.
This percentage is much lower than the international norms that health groups advise.
The remaining parks are often overcrowded and poorly maintained, limiting their usability for recreation and relaxation.

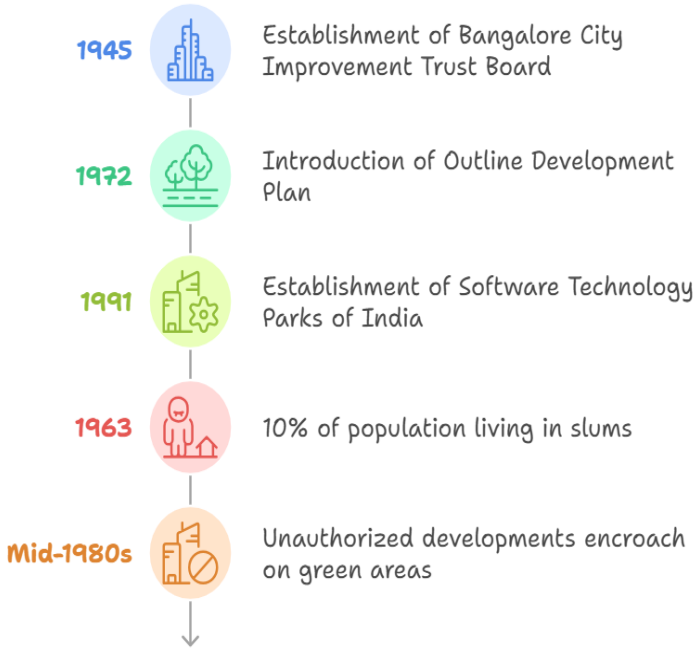


Figure 4

1.1.4.1 Bangalore is facing several significant issues related to parks.

Reduction of Green Spaces: Bangalore's title as the "Garden City" is becoming a thing of the past. The city's lung space has rapidly diminished, leading to increased health problems like allergies. According to a 2003 research, Bangalore has just 2.01 square meters of open space per person, when the WHO requires cities to have at least 9 square meters per person. **Pollution**: Air pollution is a major health hazard in Bangalore. In the past 15 years, the percentage of children with asthma has risen from 2% to 28.5%. Schools located in high-traffic areas have more students with breathing problems.

Gender Issues: An environment that is more accessible and welcoming for everybody can be achieved by including gender mainstreaming into municipal policy-making.

Traffic: Increased traffic passing through parks restricts their use to certain patches.

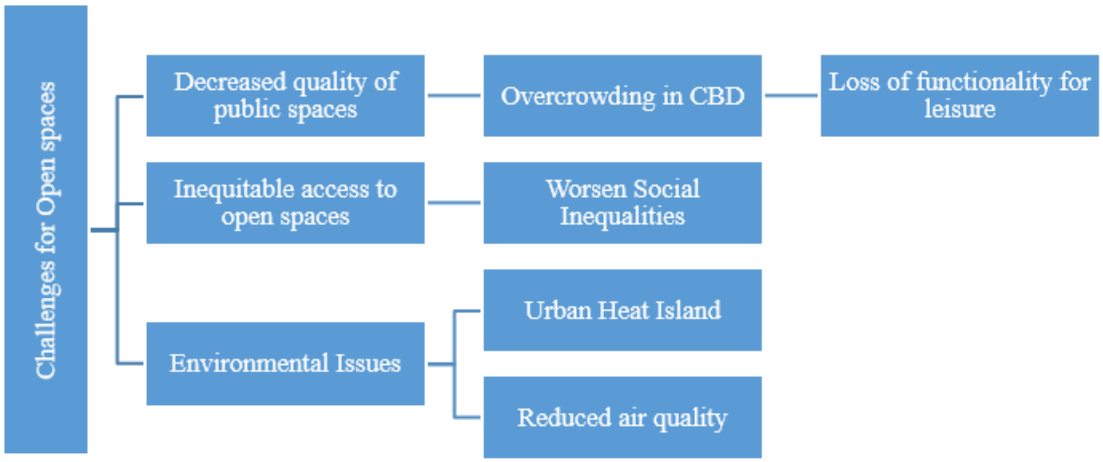


Figure 5

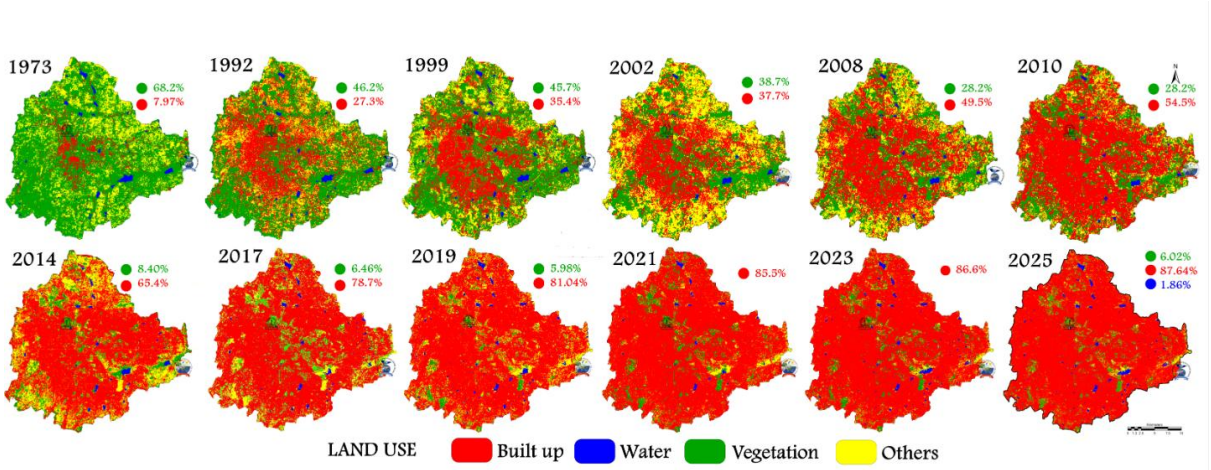


Figure 6

1.2 Synopsis:

Aim:

To evaluate the role of parks in enhancing the quality of life, using spatial analysis and remote sensing techniques and develop a strategy for open space development.

Objectives:

- To evaluate the relationship between open space and quality of life.
- To identify critical zones and wards by generating satellite imagery-derived maps
- To map and analyze the spatial distribution of existing open spaces (parks) across Bangalore using GIS techniques.
- To conduct a ward-wise analysis of parks, assessing their area, amenities, and accessibility.
- To determine the demand-supply gap through field surveys and population data analysis.
- To propose recommendations and proposals for open space development strategies.

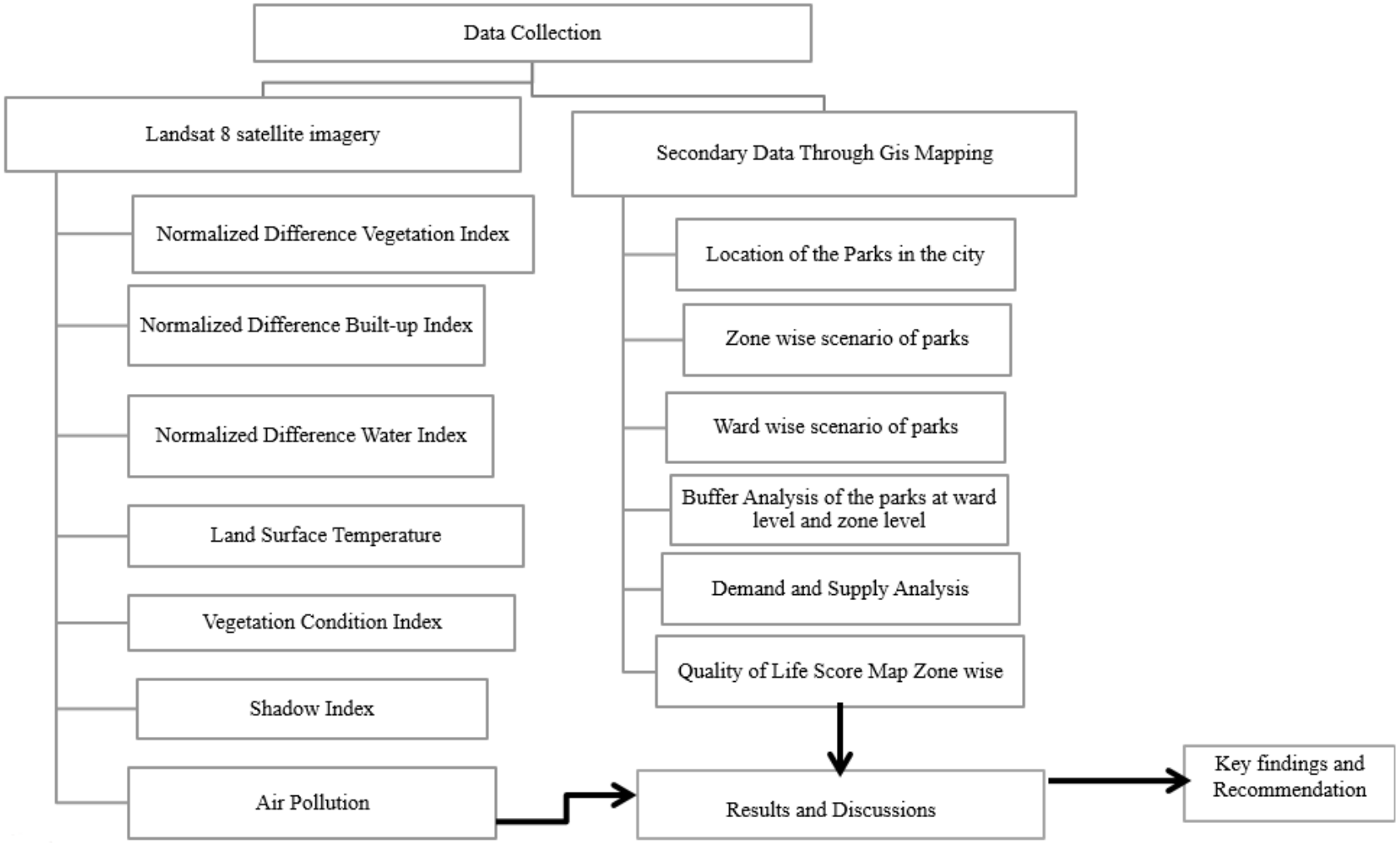
Scope and Limitations:

- The study will be limited to Bangalore city boundary only.
- The study will be carried out for parks and gardens only.
- The study will be carried out for selected zone of the city.

Need for the study:

This study is required due to increase in Bangalore's rapid urbanization, which has resulted in a significant reduction of open spaces, negatively impacting the city's microclimate, accessibility, and residents' quality of life. The city currently provides only 2.2 sq. m of open space per capita, substantially below recommended standards, leading to consequences such as urban heat island effects, degraded air quality, and limited recreational areas for inhabitants.

1.3 Methodology


Data Collection
Landsat 8 satellite imagery
Secondary Data Through Gis Mapping
Normalized Difference Vegetation Index
Normalized Difference Built-up Index
Normalized Difference Water Index
Land Surface Temperature
Vegetation Condition Index
Shadow Index
Air Pollution
Location of the Parks in the city
Zone wise scenario of parks
Ward wise scenario of parks
Buffer Analysis of the parks at ward level and zone level
Demand and Supply Analysis
Quality of Life Score Map Zone wise
Results and Discussions
Key findings and Recommendation

2 LITERATURE STUDY:

2.1 Open Spaces

2.1.1 Significance of Open Spaces.

Environmental Benefits

1. **Pollution Control:** Open spaces help mitigate pollution, a common issue in most cities.
2. **Temperature Regulation:** Trees and parks reduce noise and lower summer temperatures.
3. **Climate Mitigation:** Forested areas absorb carbon dioxide, helping to combat global warming.
4. **Water Management:** Tidal lands and wetlands absorb polluted water and prevent flooding.
5. **Water Supply:** Forests serve as a primary source of clean water.
6. **Biodiversity Preservation:** Conserving natural resources and habitats keeps ecosystems healthy.

Social and Psychological Functions

1. **Well-being:** Open spaces enhance livability and well-being by providing areas for escape and relaxation.
2. **Community Identity:** Parks and open spaces foster a sense of community and identity by offering recreational areas and attractive scenic spaces.
3. **Youth Development:** Community sports programs and conservation efforts provide positive outlets for young people.
4. **Health:** Open spaces support physical health through recreation and offer spiritual revitalization.
5. **Stakeholder Engagement:** Involving residents in maintaining and beautifying their communities strengthens community bonds.
6. **Cultural Diversity**

1. **Interaction Platform:** Open spaces act as platforms for interaction among diverse ethnic groups.
2. **Community Building:** These spaces help forge new bonds and communities, contributing to the overall quality of life.

2.1.2 Different Types of Open Spaces

The open space would be broadly categorized in to two types:

(i) Traditional Open Space and (ii) Innovative Open Space

Type	Meaning
Public Parks	A public open space; developed and managed by Parks Department as part of zoned open-space system of the city; often located near the center of the city; often larger than neighborhood parks.
Neighbourhood Parks	Open space developed in residential areas; managed by Parks Department as part of zoned open space of cities; may include playground, sport facilities, and so forth.
Playgrounds	Playground areas are located in neighborhoods; frequently includes traditional play equipment such as slides and swings; sometimes include amenities for adults, such as benches, and so forth.
Pedestrian Malls	Street closed to auto traffic; pedestrian amenities provided such as benches, planting; often located on the main street in downtown area.
Plazas	Open space developed as part of new building in downtown area; built and managed by building owners; typically privately developed and managed.

Table 1

Type	Meaning
Community Open Space	Neighborhood spaces designed, developed, owned, and/or managed by local residents on vacant land; may include viewing gardens, play areas, and community gardens; often developed on private land; not officially viewed as part of open-space system of cities; highly vulnerable to displacement by other uses such as housing.
Neighbourhood Open Space	Space located in neighborhood often near private open space, often heavily used by children and teenagers; important setting for environmental learning and socializing.
Schoolyards	Not normally considered part of open space system of cities; increased awareness as place for environmental learning; some schoolyards redeveloped as environmental centers.
Streets	Much of the publicly accessible open space of cities; increased awareness of importance of street use and traffic impacts on children; changes of streets include pedestrian improvements and sidewalk widening, street tree planting, and so forth.
Transit Malls	Development of improved transit access to downtown areas, may replace a traditional pedestrian mall with a bus and "light rail" mall.
Farmers' Markets	Open space used for farmers' markets or flea markets; often temporary or held only during certain times in existing spaces such as parks, downtown streets, or parking lots.

Town Trails	Connects parts of cities through integrated urban trails: use of street and open spaces as setting for environmental learning.
Vacant/Undeveloped Open Space	Still much of the open space in cities, found in redevelopment areas, where abandonment has occurred, or in undeveloped areas; increased awareness as potential open space; interest in vacant land being used to develop urban forests or natural areas in cities.
Waterfronts	Increased awareness of waterfronts as urban open space; many cities working to increase public access to waterfront areas by developing waterfront parks.
Found Spaces	Informal open spaces of cities where social life takes place; include street corners, sidewalks, paths connecting buildings, bus stops, steps to public buildings, and so forth.

Table 2

2.2 Quality Of Life

2.2.1 Dimensions of Quality of Life

2.2.1.1 Key Dimensions of Quality of Life:

1. Health: Physical and mental health are critical components. Health-related quality of life measures often include emotional well-being, physical functioning, and social interactions.
2. Economic Factors: Income levels, employment status, and material wealth significantly influence quality of life.
3. Environmental Conditions: Safety, housing quality, and access to amenities are vital for a high quality of life.

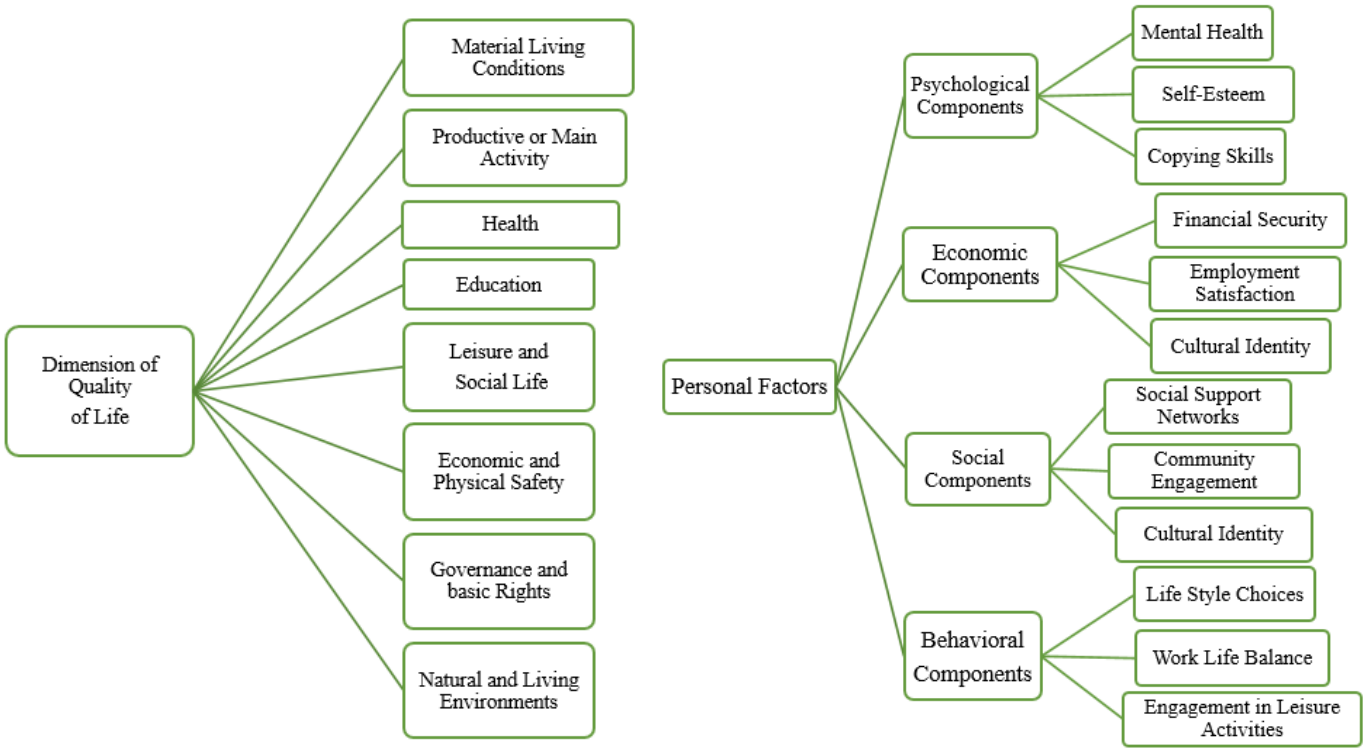


Figure 7

2.3 Parks Role in Affecting Quality of Life

The relationship between parks and green spaces with Quality of Life, especially in urban environments. While many studies focus on health behaviors like physical activity, newer research suggests that frequent park use is positively associated with Quality of Life in countries like China, Turkey, Denmark, and the United States. Even when actual park utilization is modest, perceptions of parks, such as their beauty, safety, and upkeep, can have a significant impact on quality of life.

Subjective opinions matter, as evidenced by several research that demonstrate perceived greenness doesn't always match scientifically measured greenness.

Parks are the single most important component in improving quality of life within the open space category. Empirical research indicates that parks' perceived accessibility and quality have a greater impact on community wellbeing than their actual use alone. Their contribution is both direct (through use) and indirect (through presence and perception). This emphasizes how crucial it is to enhance parks' quality, accessibility, and community integration in addition to expanding their availability. (Hanish Kodali)

Because of their size, services, natural elements, and inclusive design, parks are the best kind of open space for improving all facets of quality of life. Although gardens have significant advantages, particularly for social cohesion and mental health, their influence is frequently constrained by their smaller scale and access limitations. Plazas enhance accessibility and social life, but they don't have as many positive effects on health and wellbeing as parks and gardens.

1. Physical Health

By offering accessible, safe areas for sports, recreation, and exercise, parks promote physical activity. This results in lower blood pressure, lower cholesterol, better cardiovascular health, and a lower chance of developing chronic illnesses. Frequent park visits are linked to improved physical health overall by lowering inflammation and boosting immune systems.

2. Mental Health and Wellness

Reduced levels of stress, anxiety, and depression are associated with spending time in parks and other green areas. Being in nature promotes happy feelings, reduces rumination, and provides mental healing. Parks can improve mindfulness, attention, and cognitive functioning

while offering a respite from the overstimulating nature of metropolitan settings. According to studies, even brief trips to parks as little as thirty minutes can result in quantifiable mood and stress improvements.

3. Social Interactions

As gathering places for the community, parks promote camaraderie, social interaction, and a feeling of inclusion. They offer spaces for get-togethers, activities, and casual interactions that enhance social capital and community relationships. Improved social interactions in parks can lead to increased life satisfaction and general well-being.

4. Environmental Benefits

Parks enhance the visual appeal of urban settings, increasing the appeal and livability of cities. They immediately improve environmental quality and public health by lowering pollution, cooling cities, and purifying the air.

5. Accessibility and Perception

Higher quality of life is significantly correlated with the sense of having good parks close by, often even more so than actual park use. Regardless of how frequently they visit, locals say that having access to quality parks improves their sense of community and personal wellbeing.The existence and perceived quality of parks can improve neighborhood happiness and community pride, therefore investing in parks benefits not only regular visitors but the entire community.

Parks' Impact on Community Wellbeing
Parks significantly enhance community wellbeing and quality of life.
Accessibility
Quality
Community Integration
Direct Use
Indirect Presence
Pollution Reduction
Green spaces filter pollutants, enhancing air quality.
Vegetation
Parks provide shade and cool the air through evapotranspiration.
Transportation Links
Connecting neighborhoods to parks through public transport systems
Equitable Access
Ensuring all residents have park access regardless of socio-economic status

Figure 8

Aspect	Contribution of Parks with Quality of Life	Impact on Urban Planning
Physical Health	Encourages physical activity (walking, exercise, play), reduces obesity, and improves overall health	Design accessible, safe, and ample open spaces to promote active lifestyles
Mental Health	Provides stress relief, relaxation, and restorative natural environments	Integrate green spaces that offer tranquility and psychological benefits
Social Cohesion	Facilitates social interaction, community gatherings, cultural events, and inclusivity for diverse populations	Plan inclusive, multi-use open spaces that foster community engagement and social integration
Environmental Quality	Improves air quality, reduces urban heat island effect, supports biodiversity, and enhances urban aesthetics	Preserve and expand green areas to promote sustainability and environmental resilience
Economic Value	Increases property values, attracts residents and investment, and supports local economies	Invest in quality open spaces as part of urban regeneration and economic development strategies
Urban Livability	Enhances overall attractiveness, resilience, and sustainability of cities	Prioritize open spaces to create healthy, vibrant, and adaptable urban environments
Inclusivity & Accessibility	Ensures all community members, including marginalized and disabled groups, can use and benefit from open spaces	Design barrier-free, well-distributed open spaces accessible to all demographics

Table 3

2.4 Norms and Standards

2.4.1 Indian Standards

Hierarchy of the Urban open spaces

Level	Size Range	Examples
Tot Lot	≤ 150 m²	-
Neighbourhood Level Parks	150-400 m²	-
City-Level Parks	1-20 acres	-
Regional Level Parks	20-40 acres	-
State-Level Parks	40-100 acres	Brindavan Gardens (60 acres)
National Level Parks	>100 acres	Sundarbans, Nagarahole, Bannerghatta, Bandipur

Table 4

2.4.2 Karnataka Standards

In Karnataka, the norms for open spaces are guided by various regulations, including the Karnataka Parks, Play-Fields and Open Spaces (Preservation and Regulation) Act, 1985.

A. KTCP Act 1961 Sub-section (3) Inserted by Act 1 of 2005 w.e.f. 14.2.2005.

The benefit of development rights. - When a local government or planning authority mandates the creation of open spaces in any part of a local planning area. The government is making many environmentally biased decisions in the name of development, but they are not include the replenishment process in the program, which reduces the city's green cover and pollutes the environment.

- Strategies and policies

  The goal of the metropolitan Open Space project is to present a thorough analysis of the ways in which metropolitan areas might improve the quality, appeal, and dignity of urban life. The way Bengaluru city has changed over time due to population growth and a high demand for housing has an impact on open spaces.

  Open Space Requirement: The state mandates that **15% of total land** use should be designated for parks and open spaces. Alternatively, this translates to **one hectare of open space per 1,000 population.**

Urban Planning Guidelines: The Karnataka Urban Development Authorities (Amendment) Bill has proposed reducing the mandatory percentage of open spaces from **15% to 10%** in government layouts, aligning them with private developers' requirements.

Current Policies on Open Spaces:

• **Karnataka Urban Development Authorities (Amendment) Bill-2016**: In order to lower the cost of government housing sites, the measure aims to lower the required percentage of parks and open spaces by government development authority from 15% to 10%. Over the past few decades, this has resulted in a notable loss of lakes and green cover.

Impact on Public Spaces: The bill allows shrinking public space opportunities and legalizes encroachments, benefiting land sharks and irresponsible builders with no advantages for the city or its citizens.

• **Government's Stance**: The government justifies the amendment by claiming it will reduce housing costs, but it has also led to the loss of 66% of the city's green cover and 74% of its lakes.

• **Public Opposition**: The bill was passed without public discussion, leading to resistance from citizens. Increased green cover improves air quality, reduces pollution, and enhances water and soil quality.

• **Future Planning**: The guidelines suggest increasing urban landscaping to encourage non-motorized transport and enhancing properties with views of parks or lakes.

2.4.3 Other Countries Standards

City	Country	Norm (m^2 per capita)	Details
London	England	70	20 – neighboring park, 10 – sports ground, 40 – urban park
Stockholm	Sweden	39.4	5.6 – neighboring park and quarter park, 10 – sports ground, 23.8 – city park
Rome	Italy	27.8	3.2 – playground, 5.5 – adjacent park, 11.6 – city park
Amsterdam	Netherlands	15.5	9 – city park, 6.5 – sports ground
Hannover	Germany	5	1 – playground, 1 – sports ground, 3 – free playground
Los Angeles	USA	4,000	48.5
Cambridge	England (UK)	124	46
London	United Kingdom	8,900	40
Washington	USA	633	38
Kansas	USA	2,912	36.4
Minneapolis	USA	422	20
Bristol	USA	536	10
India	India	-	8
Pakistan	Pakistan	-	5

Table 5

2.5 Open Space Development Strategies

2.5.1 About the Strategy

Within a city, municipality, or particular area, an Open Space Development Strategy (OSDS) is an accurate long-term plan that directs the creation, enhancement, and administration of open spaces, including parks, gardens, and sports fields, natural reserves, and urban plazas. The strategy aims to guarantee that open spaces promote biodiversity, improve quality of life, meet present and future community requirements, and aid in sustainable urban growth.

2.5.2 Key Goals

Evaluate the demand and supply: Recognize any holes or shortcomings in the open spaces that are already provided.

Organize planning: Encourage various agencies and stakeholders to follow a common approach to open space planning.

Establish goals and a vision: Clearly state the goals, priorities, and vision for the development of open spaces.

Direct management and investment: Provide information for choices for programming, maintenance, improvement, and land acquisition.

Encourage fairness and accessibility by making sure that open spaces are dispersed equitably and that everyone in the community may access them.

2.5.3 Benefit of Making Strategy

The benefit of preparing a strategy is the protection and creation of a network of high-quality open spaces that can:

Encourage civic pride and local identity improve an area's physical character, influence current and future development, and promote social and physical inclusion. This includes making an area more accessible, creating pathways for wildlife, recreation, walking, and bicycling, safer routes to schools, protecting and enhancing biodiversity, ecological habitats, green infrastructure, and ecosystem services for kids. Play and recreation among young people increase property values, promote urban renewal, increase the economic potential of tourism, and provide cultural, social, recreational, athletic, and communal services. Preserve and advance knowledge of the historical, cultural, and archaeological significance of locations; help

create healthy spaces; and offer well-liked outdoor learning opportunities. Encourage local food production, aid in climate change adaptation and mitigation, and enhance possibilities for people to enjoy nature.

2.5.3 Key Elements

- **Inclusivity:** Consider all types of open space, including those privately owned but accessible to the public (e.g., school fields, plazas)
- **Sustainability:** Plan for climate resilience, biodiversity, and long-term financial viability
- **Adaptability:** Ensure open spaces can respond to changing recreational, environmental, and community needs
- **Safety and Accessibility:** Design for safety, universal access, and community use.

2.5.4 Steps for Implementation

The implementation of an Open Space Development Strategy (OSDS) follows a structured, multi-stage process.

Step	Key Outputs
Project Planning & Establishment	Scoping report, vision, work program, engagement plan
Background Research & Context	Context summary, policy review
Audit & Supply Assessment	GIS database, open space inventory
Demand & Needs Assessment	Community needs summary, consultation outcomes

Gap Analysis & Objective Setting	Deficiency analysis, draft objectives, standards
Draft Strategy & Consultation	Draft strategy, action plan, public feedback
Finalization & Adoption	Final strategy, council adoption
Implementation Program	Action plan, funding plan, statutory integration
Monitoring & Review	Progress reports, periodic reviews

Table 6

2.5.5 Case Study

1. **Pune Urban Greenways:**

It examines how urban green spaces (UGS) and urban greenways (UGWs) can help revitalize Pune, India, amid rapid urbanization. Urban greenways, which are linear open space networks**,** provide both ecological and socioeconomic benefits by connecting green spaces and improving urban environments.

2. Hyderabad Urban Park Initiatives:

The Telangana Forest Department has proposed the development of 59 blocks around Hyderabad into urban parks, offering city residents much-needed recreational spaces. A key focus of the initiative is to create green spaces near software industry hubs, catering to employees working from home.

3. Veer Savarkar Udyaan, Mumbai:

It highlight the significance of stakeholder participation in the redesign of urban parks and explores how community involvement in park planning and design enhances usability, satisfaction, and adoption of public spaces.

Aspect	Veer Savarkar Udyaan, Mumbai	Hyderabad Urban Parks Initiative	Pune Urban Greenways Framework
Location	Borivali (West), Mumbai, Gautam Nagar area, ~1.6 km from Borivali West Railway Station; surrounded by vehicular roads	Hyderabad, Telangana; city-wide initiative spanning various neighborhoods and IT corridors	Pune, Maharashtra; city-wide analysis and intervention targeting fragmented green spaces across urban wards
Challenges & Problems	- Limited accessibility (no universal design) - Underutilized amphitheatre, seating, boating lake - Poor maintenance (benches, toilets, lighting) - Crowded gym area - Noise pollution - No cycling infrastructure	- Urban sprawl, pollution, and loss of green cover - Encroachment and dumping on open lands - Lack of accessible parks in new developments	- Unequal distribution of green spaces - Rapid urbanization, loss of vegetation - Pollution, urban heat islands - Limited accessibility - Policy gaps in planning
Analysis/Approach	- Stakeholder participatory design - User surveys, interviews - Usage pattern mapping - Collaboration with designers, users, agencies	- Urban Biodiversity Wing for planning - Data-driven identification of lung spaces - Community, corporate, and NGO involvement	- GIS mapping of green spaces - Ward-wise assessment vs. URDPFI & WHO guidelines - Public perception surveys
Implementation	- Improved seating in shaded areas - Better lighting & security - Dedicated cycling track & parking	- Development of 111 urban lung spaces, 59 new parks - Multi-layer avenue	- Proposed urban greenways to connect parks - Improved accessibility and usability - Integrated vegetation

	- Enhanced amphitheater acoustics - Nature & butterfly park - Improved maintenance and accessibility	plantations - Open gyms, vertical/rain gardens - 10% city budget for greening - Community and school involvement	corridors - Promotion of walking and cycling
Success & Impact	- Increased park usage, especially by youth and families - Higher user satisfaction - Community engagement ensured better adoption - Enhanced ecological value, biodiversity	- Forest cover increased by 147% (2011–2021) - Recognized as "Tree City of the World" - Improved air quality, biodiversity, and recreation	- Identified key deficiencies in green space planning - Recommendations for urban greenery improvement - Highlighted health and ecological benefits

Table 7

3 STUDY AREA:

3.1 Location of the City

Bangalore is located in the centre of the South Indian Peninsula, evenly distanced from the eastern and western coasts (latitude 12° 58 North and longitude 73° 36 East) and at an elevation of around 931 meters above mean sea level. It is well known for having a healthy and balanced atmosphere. Bengaluru, the capital of Karnataka, is India's fifth largest metropolitan area. Established in 1537, it grew from a tiny community to become India's preeminent scientific and technological hub and a fierce rival on the world stage. Between 1985 and 2015, the city's built-up area increased from 192 to 518 square kilometres, a 170% increase. The Bruhat Bengaluru Mahanagara Palike (BBMP), which spans over 713 square kilometres, was created in 2007 by the merger of the Bangalore City Corporation and the neighbouring territories. According to the 2011 Census, the 713 square kilometre municipal corporation was home to 84, 43,675 (8.43 million) people.

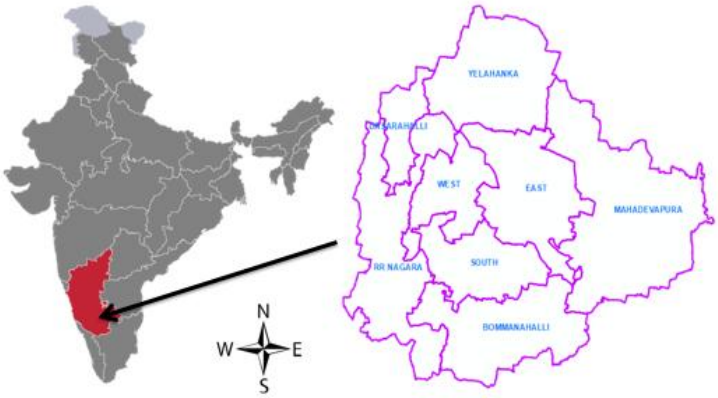


Figure 9

Over time, it also developed into a major hub for healthcare and education, and trade and business thrived rapidly. The next stage of development was made possible by this ideal combination of science, research, and industry, as well as the comforts of a contemporary, international metropolis and a pleasant environment. Bengaluru led India's biggest IT and biotechnology revolutions during the 1990s and 2000s, which saw a significant technological growth.

A substantial portion of the city's economic production comes from a variety of industries, including engineering, automotive, textiles and apparel, floriculture, defense and aviation, and high-tech services.

3.2 History, Growth and Development

Karnataka's capital, Bangalore, has a rich 400-year history. The fact that Bangalore is mentioned in various forms in inscriptions dating back hundreds of years attests to the city's ancient status. It appears that people have lived in Bangalore since the first century A.D. Roman coins have been discovered in the area now occupied by Hindustan Aeronautics Limited and Yeshwanthapur. Up until the tenth century A.D., the Bangalore region was governed by the Gangas for six centuries before falling under the Cholas. At the Nageshwara Temple in Begur, a village in the eastern region of modern-day Bangalore, the term "Bengalooru" appears in an inscription from the Ninth Century A.D. The late Shri Magadi Kempegowda created Bangalore City in 1537, marking the city's beginnings. However, the British Government had direct control over the cantonment and the surrounding civic regions, while the State Government of Mysore was in charge of running the city. Only in the middle of 1946 were the civil areas turned over to the State, and in 1949, Bangalore's city and civil areas were unified under the Corporation of the city, which had a population of nearly 7,000,000. The city's most remarkable expansion may have begun after the nation gained its independence. Bangalore's growth was further accelerated in 1956 when states were reorganized linguistically, making it the capital of a larger state called Mysore, which also included major Kannada-speaking regions of the erstwhile Bombay, Hyderabad, Madras, and Kodagu states. In addition to serving as Karnataka's administrative and educational hub, Bangalore experienced rapid expansion as a major industrial hub in the nation. It is currently India's Silicon Valley.

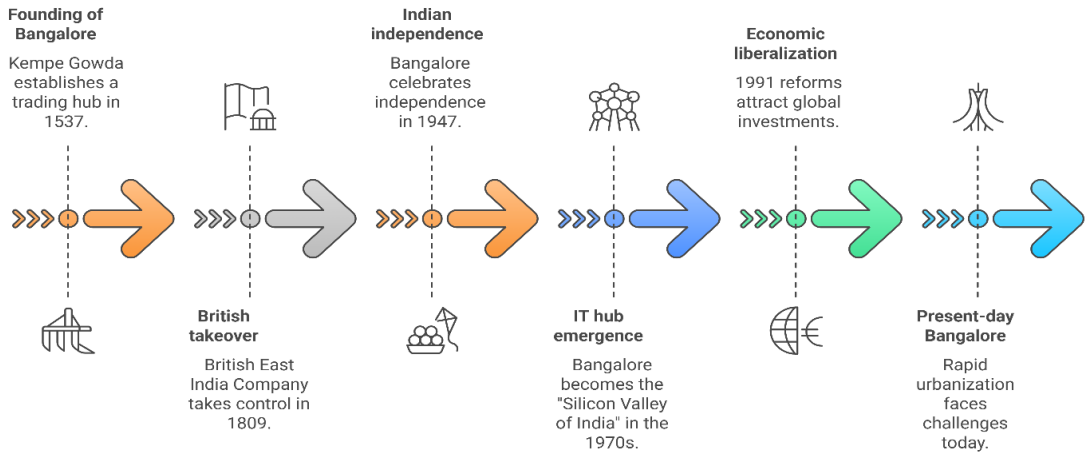

Founding of Bangalore
Kempe Gowda establishes a trading hub in 1537.
British takeover
British East India Company takes control in 1809.
Indian independence
Bangalore celebrates independence in 1947.
IT hub emergence
Bangalore becomes the "Silicon Valley of India" in the 1970s.
Economic liberalization
1991 reforms attract global investments.
Present-day Bangalore
Rapid urbanization faces challenges today.

Figure 10

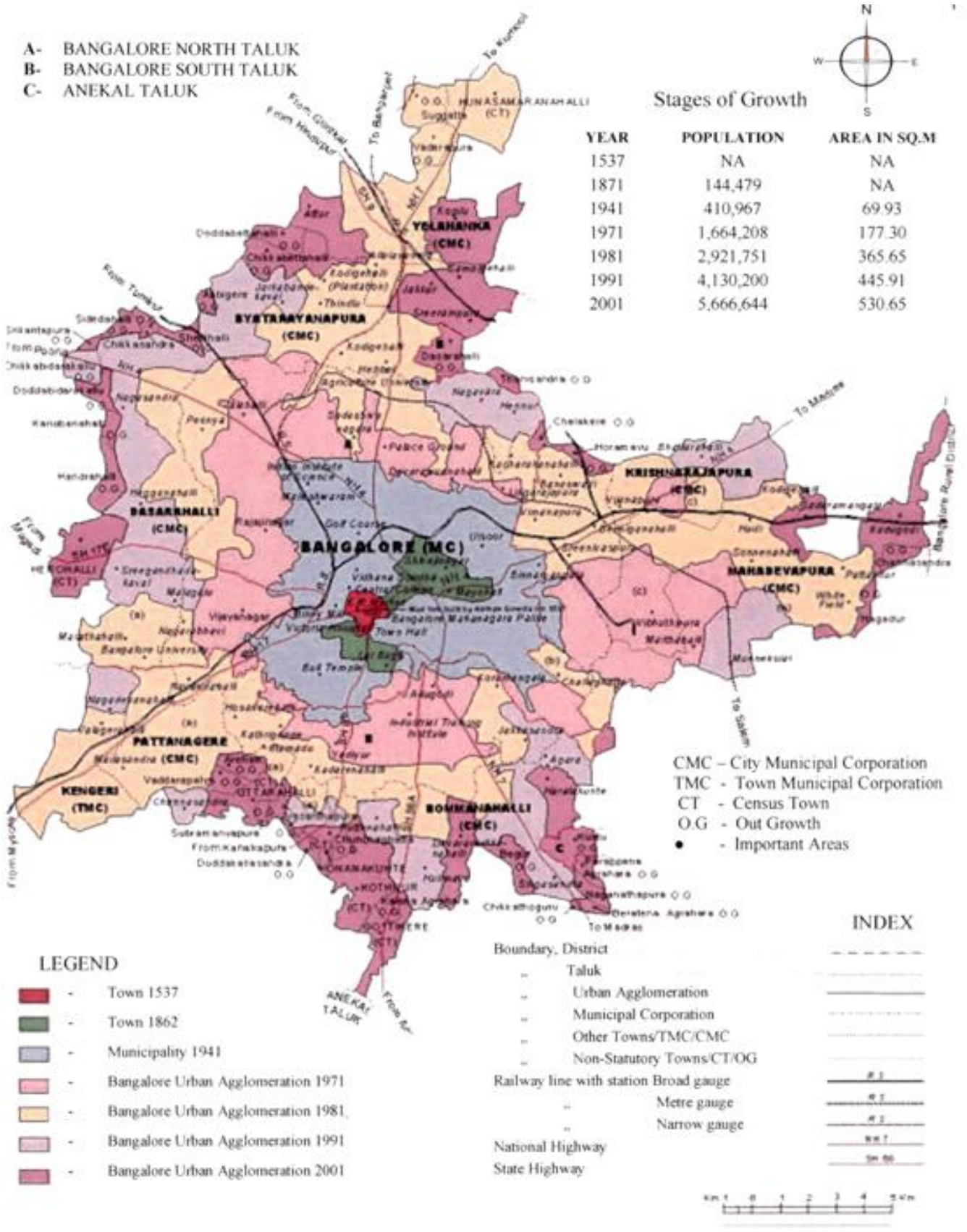


Figure 11 *(RAJAN)*

3.3 Topographical Features

The city's topography includes a smooth ridge that runs north to south and descends towards the east and west. Rainfall in the ridge region is split and either flows west or east. The water eventually joins south Pinakini after flowing down the ridge's eastern flank, and it also follows Arkavathi's course in the west. One of the highest points in Karnataka's plain (maidan) region is the'residency' area of Bangalore, which is 900 meters above sea level. All of the rainwater that falls on this type of terrain tends to run off. Since ancient times, a portion of the flow has been leaking into the earth to be stored in the fissures of hard rock at deeper depths as well as in the spaces between weathered rock formations coated by a thin layer of soil.

3.4 Climate

Bangalore, also called as the "air-conditioned" city of South India, is renowned for its pleasant and healthy climate. Bangalore's climate may be categorized as tropical monsoon based on Koppen's wide climatic categorization. The pleasant temperature range of 33°C in April to 14°C in January, as well as the two rainy seasons of June to September and October to November, which occur consecutively but have opposing wind regimes the southwest and northeast monsoons, respectively are the primary characteristics of Bangalore's climate. Significant thunderstorm activity is also common in April through May and September through October, with sporadic hailstorms and squalls. A little over half of the 844 mm of annual rainfall falls during the southwest monsoon season, while roughly a quarter falls during the northeast monsoon season. April and May also get a fair amount of rainfall. The early morning dew and mist or fog from October to February, the preponderance of low cloud cover, and the generally consistent temperatures with little daily variation throughout the entire monsoon season (June to October) are two other noteworthy features.

3.5 Demography of the City

According to the 2001 Census, there were 5.69 million people living in the Bangalore Metropolitan Area, compared to 4.13 million in the 1991 Census. Bangalore rose from sixth place in the preceding ten years to fifth place among India's largest metropolitan cities, according to the 2001 Census. There are currently an estimated 7 million people living in the Bangalore Metropolitan Area, and that number is expected to rise to 9 million by 2011.The city's already overburdened infrastructure would be further burdened by the growing population, environmental degradation, and deteriorating quality of life. The burden brought on by the city's steadily growing floating population of 1.5 to 2.0 million people is another

factor. The city's built-up area increased by 170 percent in just 30 years, from 192 square kilometers in 1985 to 518 square kilometers in 2015.In 2007, the 226 square kilometer Bangalore City Corporation region was combined with the eight nearby municipal corporations and 110 nearby villages. With a total size of roughly 713 square kilometers, the newly enlarged municipal corporation territory was dubbed Bruhat Bengaluru Mahanagara Palike (BBMP). According to the 2011 Census, the 713 square kilometer municipal corporation was home to 84,43,675 (8.43 million) people. According to the analysis done for this study, there will be 101,76,238 (10.17 million) people living under the BBMP jurisdiction in 2019. Bengaluru is home to a sizable portion of Karnataka's urban population, with 36% of the state's urban population residing in the BBMP region (Census 2011). As a result, the state is experiencing Bengaluru-centric urbanization.

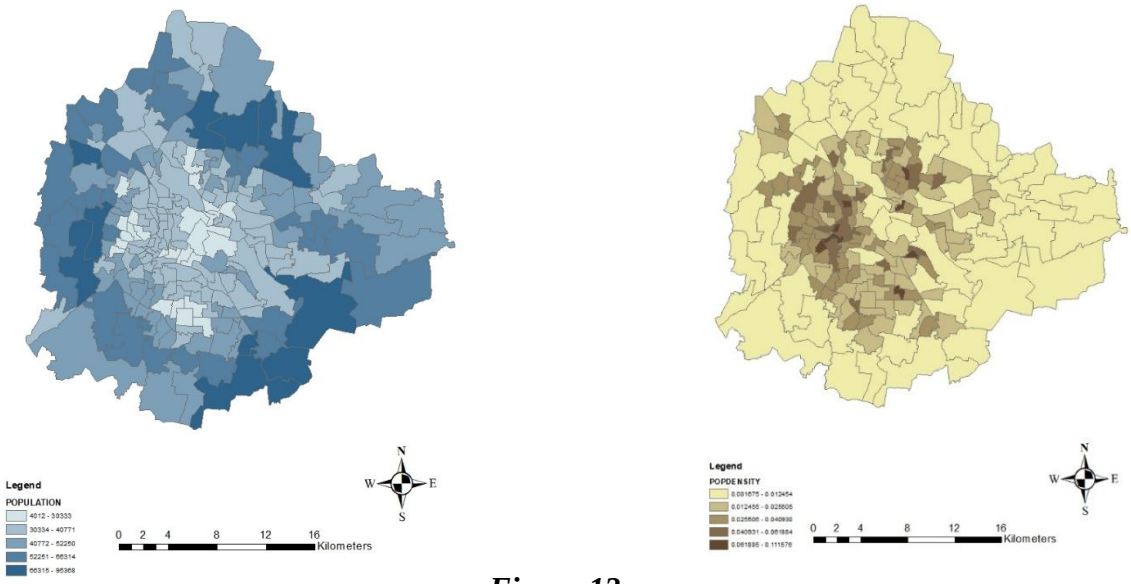


Figure 12

Every ten years, the urban agglomeration and municipal limits have evolved. Despite certain fluctuations over the years, BBMP has continuously grown at rapid rates. Between 2001 and 2011, the BMA villages' growth rate doubled. According to the 2001 Census, there were 5.69 million people living in the Bangalore Metropolitan Area, compared to 4.13 million in the 1991 Census. Bangalore rose from sixth place in the preceding ten years to fifth place among India's largest metropolitan cities, according to the 2001 Census. The city's unnatural population and area development has led to issues with the availability of basic social and physical facilities, as well as increased per capita maintenance and upgrading costs.

3.6 Parks In Bangalore

3.6.1 Evolution of Parks in Bangalore

There are a lot of parks and gardens in Bangalore these days, but Lalbagh Garden and Cubbon Park are two of the most significant. Cubbon Park was created in 1864 by Sir Richard Sankey.The location for Attara Kacheri was Cubbon Park. Currently, Cubbon Park is located in the city center on roughly 150 acres of land. The total size of Lalbagh Garden is around 97 hectares. It was once just 16.2 hectares and was constructed during the rule of Hyder AH. The Mughal garden at Sira served as an inspiration for the original design. There used to be a tiny, well-liked zoo there. The military band used to perform at a bandstand that was constructed in the middle of the 1800s. Up until 1976, an orchestra performed there following independence.

Period	Development & Changes
1537 AD – 1791 AD	Kempegowda I & II established Bangalore with temples, lakes, and planned residential layouts. Lalbagh Garden was created by Hyder Ali in 1760 AD, influenced by Mughal gardens.
1791 AD – 1947 AD	British Colonial Era: Bangalore became a cantonment city, leading to the development of Cubbon Park (1864 AD) by Sir Richard Sankey as a green buffer between the Indian city and the colonial city.
1947 AD – 1970 AD	Post-Independence Growth: Bangalore merged its Indian & colonial cities, maintaining Cubbon Park & Lalbagh Garden. The Silver Jubilee Park (1927 AD) was established. By 1970, Bangalore had 13 big parks, 30 small parks, and 52 circular gardens.
1970 AD – 1990 AD	Rapid Urbanization: Bangalore's population boom led to encroachment on parks & lakes. The 1995 CDP proposed regional parks to counter the loss of green spaces.

1990 AD – Present	Modern Expansion & Conservation Efforts: Bangalore now has over 416 neighborhood parks and major green spaces like Sankey Tank, Cariappa Memorial Park (1996 AD), and Freedom Park. However, encroachment and infrastructure pressure continue to threaten open spaces.

Table 8

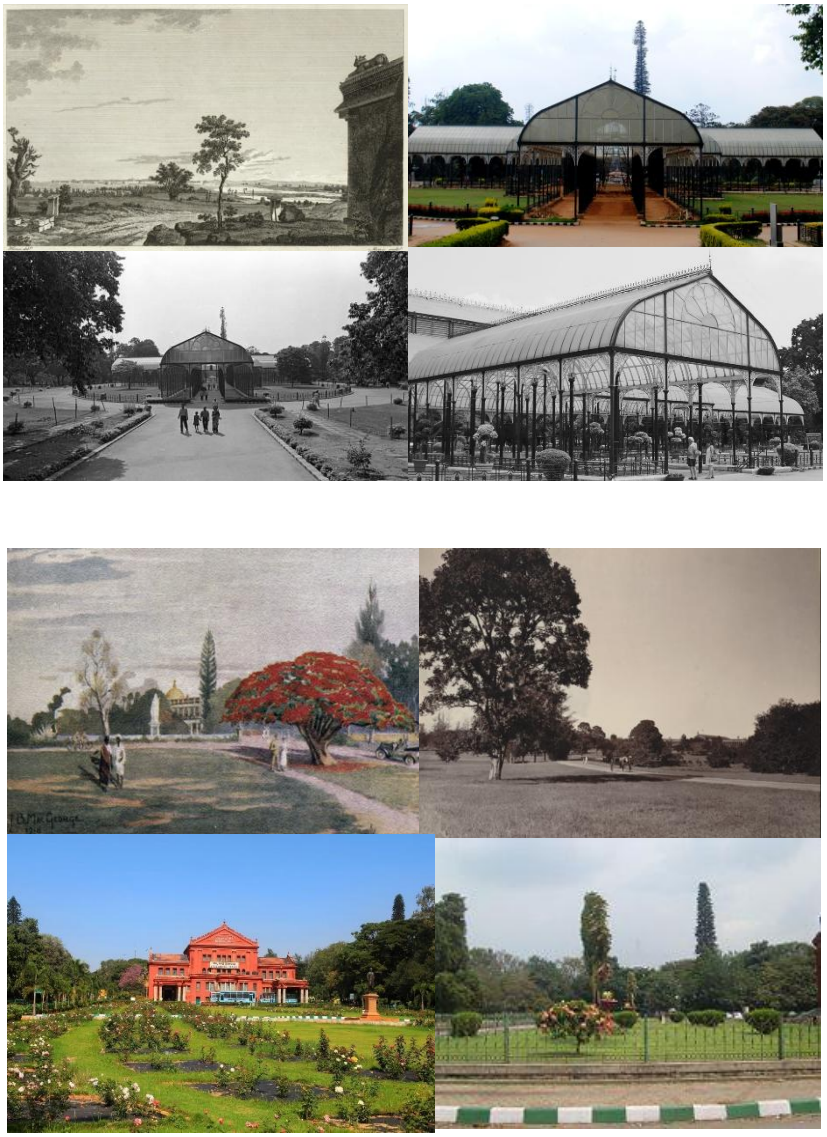


Figure 13

3.6.2 Key Parks and Gardens in Bangalore

Park/Garden	Significance	Features
Cubbon Park	Established in 1864 by Sir Richard Sankey, serves as a green buffer between old and new Bangalore	150 acres of greenery Attara Kacheri (High Court), Central Library, State Archaeological Museum Children's park, amusement ground Shady trees, bamboo groves, ponds, promenades
Lalbagh Garden	Developed by Hyder Ali in 1760, expanded by Tipu Sultan, modeled after Mughal gardens	97 hectares botanical garden Glass House (modeled after Crystal Palace, England) Lalbagh Lake (30 hectares, bird habitat) Kempe Gowda tower, horticultural exhibitions
Cariappa Memorial Park	Developed by the Indian Army in 1996, named after Field Marshal Cariappa	Naturalistic garden Waterfalls, children's play area
Sankey Tank	Popular among northern suburb residents	Water body with scenic surroundings

Table 9

Cultural & Recreational Importance

Public Events: Military bands performed for the general public at Cubbon Park's bandstand.

Parks serve joggers, families, students, and nature enthusiasts as places to unwind and engage.

Symbolic Significance: These parks are still maintained and improved since they are so integral to Bangalore's identity.

Aspect	Before (Pre-1990s)	Now (Present Day)
Park Size & Coverage	Large parks like Cubbon Park (150 acres) & Lalbagh Garden (97 hectares) dominated the city	Increased neighborhood parks (416+), but major parks face encroachment
Green Cover	Bangalore was known as "Garden City" due to its extensive greenery	Urbanization has reduced green spaces, but conservation efforts are ongoing
Public Engagement	Parks were community hubs with bandstands, promenades, and cultural events	Parks now cater to joggers, families, and recreational activities, but some lack maintenance
Threats & Challenges	Minimal urban pressure, parks were well-maintained	Encroachment, pollution, and infrastructure expansion threaten green spaces

Table 10

Regional parks proposed in 1995 CDP to expand green spaces**.**

Urban planning initiatives aim to preserve existing parks and develop new ones**.**

Community-driven conservation efforts are increasing awareness about sustainable urban greenery**.**

4 DATA COLLECTION AND ANALYSIS:

4.1 Parks Distribution

With an area of 709 square kilometers and a population of 12 million (an estimated estimate of 8.4 million according to the 2011 census), Bengaluru only has 19.31 square kilometers set aside for open spaces like parks and playgrounds. This translates to 2.2 square meters of open space per person, which is much less than the 10–12 square meters that the Ministry of Urban Development (MoUD), India, recommends under the URDPFI (Urban and Regional Development Plans Formulation and Implementation*) recommendations.

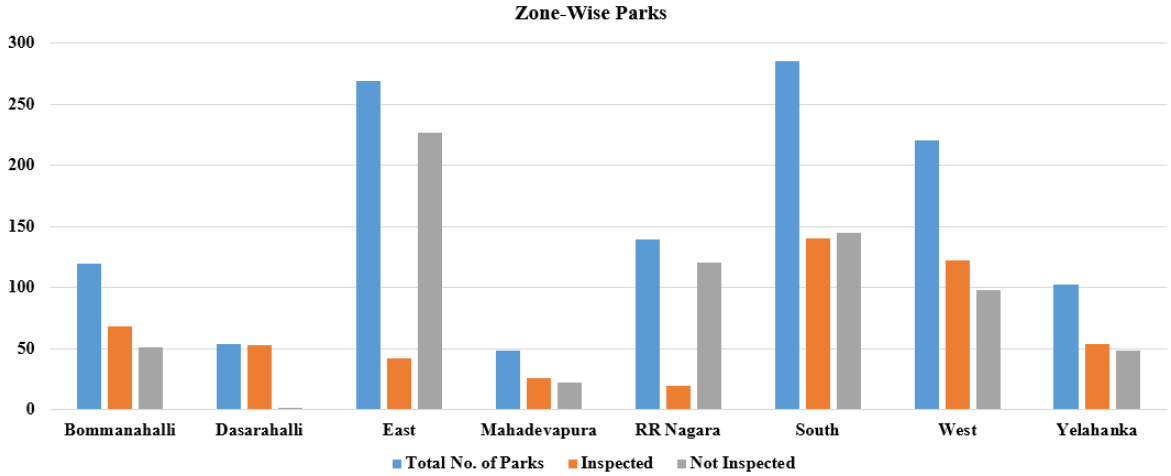


Figure 14

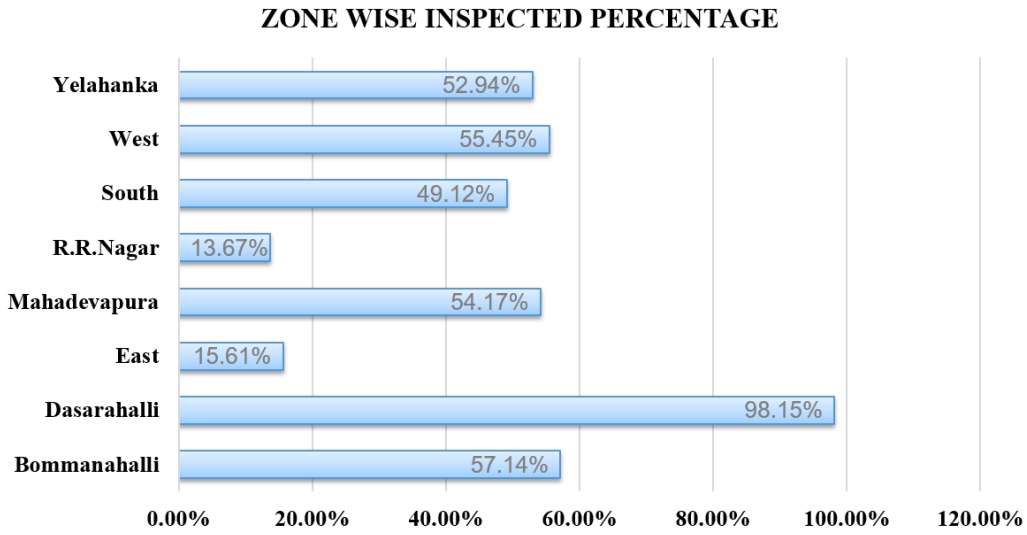


Figure 15

Inspection Condition	Description
Landscape Development	Assessment of greenery, lawns, trees, and overall landscaping.
Civil Works	Evaluation of pathways, boundary walls, benches, and other civil structures.
Maintenance of Facilities	Check for cleanliness, waste bins, and regular upkeep.
Horticultural Condition	Review of plant health, flower beds, and gardening activities.
Infrastructure for Differently Abled	Availability of ramps, accessible paths, and facilities for disabled persons.
Solid Waste Management	Facilities for collection, segregation, and composting of solid waste.
Security and Safety Measures	Adequacy of lighting, fencing, and security arrangements.

Table 11

South Zone has the highest no. of parks, followed by East, West, RR.Nagara, Bommanahalli, Yelahanka, Dasarahalli and Mahadevapura Zone.

Highest percentage of parks in good condition are from Dasarahalli zone and least percentage of parks in good condition are from RR.Nagara.

Highest number of parks are located in Jnana Bharathi Ward followed by Hemmigepura located in RR.Nagara.

Wards like T Dasarahalli, Vishwanath Nagenahalli, Nagavara, Laggere, Chickpete, Nilasandra and Chelavadi Palya does not have any park.

The city core has reasonable access to organized green open spaces.

The periphery of the city has the least provisioning of organized green open spaces.

South Zone leads in almost all categories:

- It has the most number of parks.
- It also has the highest number of parks in good condition.
- It has the highest number of registered Hasiru Mitras.
- It has the most BBMP officials and maintenance agencies.

Mahadevapura Zone

- Has the least parks.

Dasarahalli Zone

- Have parks in good condition.

East Zone

- Has the most parks in the worst condition and also has the highest number of uninspected parks.

Inspection rates

- South Zone has the highest number of inspected parks.
- RR Nagar has the lowest inspections.

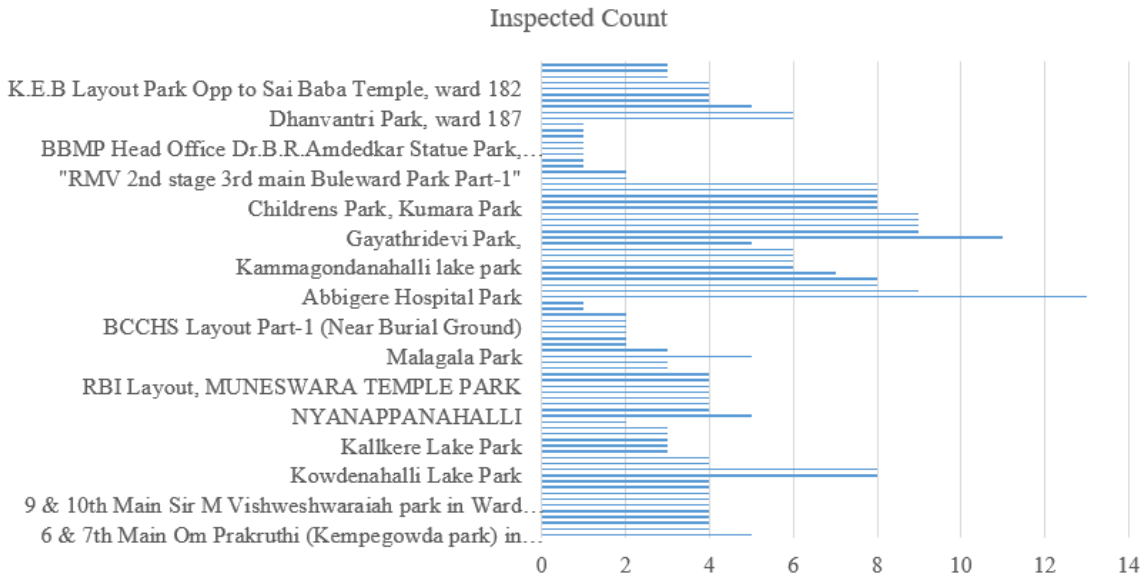


Figure 16

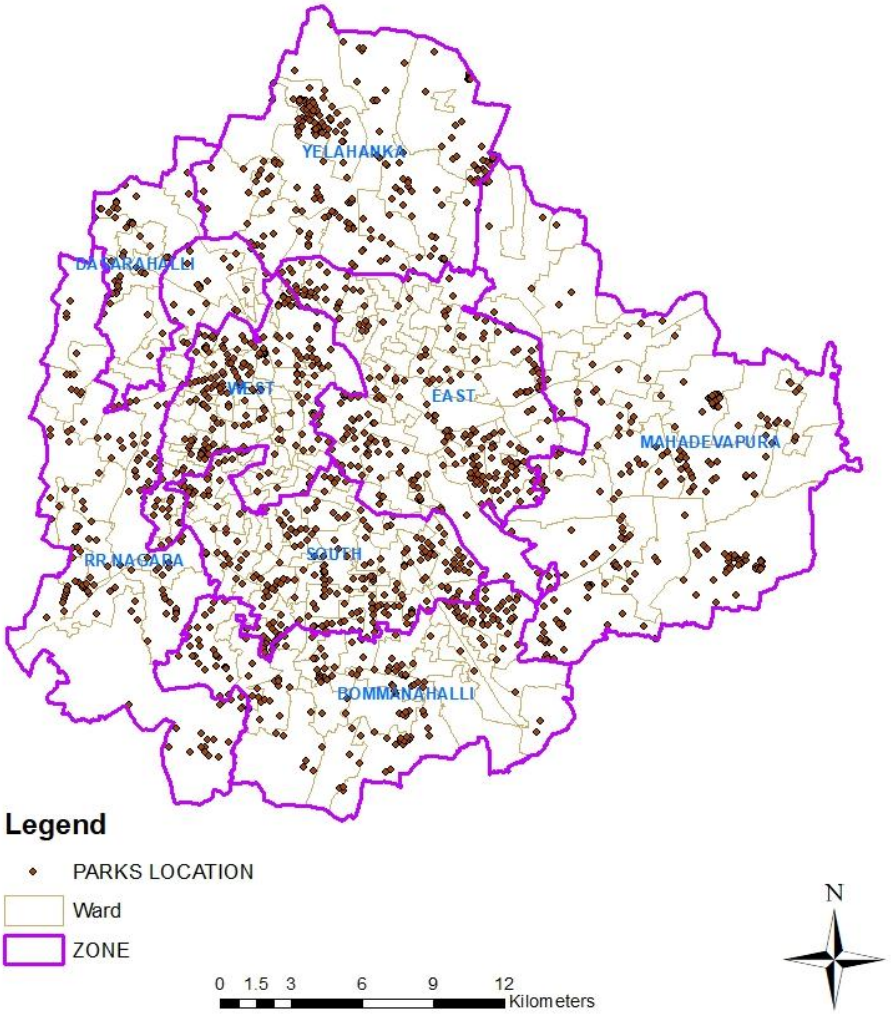


Figure 17

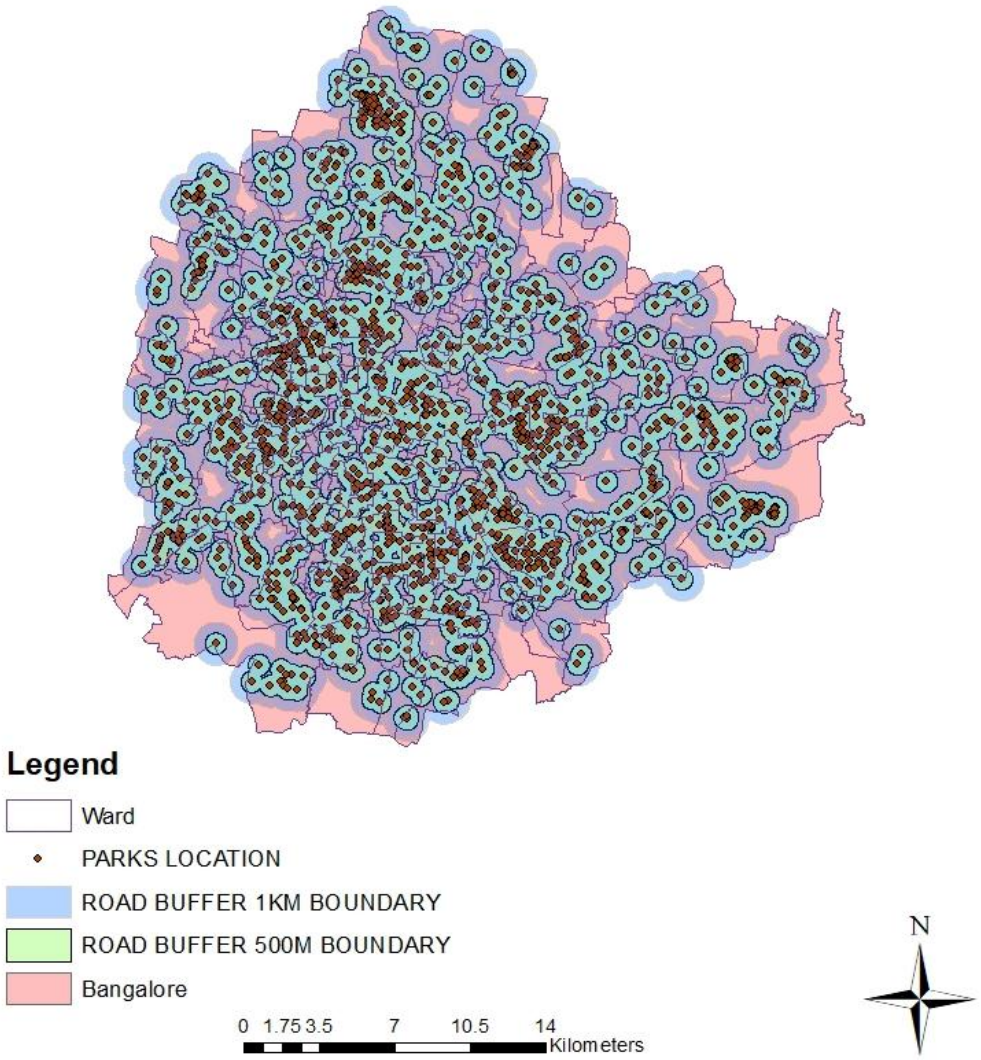


Figure 18

There is an uneven distribution of parks, with central areas showing higher concentrations compared to peripheral regions. The 500m buffer analysis reveals significant gaps in walkable access to parks across the city. Many residential areas fall outside these buffers, indicating limited pedestrian accessibility to green spaces. The central zones (East and West) demonstrate better walkable access compared to peripheral zones like Mahadevapura. The 1-5km buffers, coverage improves dramatically, with extensive overlapping service areas, particularly in central regions. This indicates that walkable access may be limited in some areas, most residents can reach parks within a reasonable travel distance. The buffer overlaps in central areas indicate potential redundancy in park services, while minimal overlap in peripheral areas suggests limited park options for residents in those regions.

4.2 Accessibility through Buffer Analysis

Buffer analysis is a GIS technique that creates zones of a specified distance. The main purpose of this analysis is to evaluate spatial relationships and accessibility to important services or infrastructure within a particular distance.

Key reasons for performing buffer analysis for accessibility:

- Assessing Service Reach: It helps determine which areas or populations are within easy reach of essential services such as schools, hospitals, parks, or public transport stops.
- Urban Planning: Planners use buffer analysis to ensure equitable distribution of amenities and identify underserved areas, supporting decisions on where to locate new infrastructure.
- Policy and Resource Allocation: Buffer zones highlight gaps in service coverage, allowing policymakers to prioritize investments and interventions in areas lacking access.
- Emergency Planning: Identifying which buildings or people fall within risk zones (e.g., near hazardous sites) for evacuation or disaster management.
- Environmental Management: Used to delineate areas affected by environmental hazards or needing protection, such as rivers or contaminated sites.

4.2.1 Buffer Analysis for 500 M

Short Walking Distance: 500 meters is considered a comfortable walking distance for most people (about 5–7 minutes).

Immediate Accessibility: It reflects the area that people can easily and quickly access by foot.

Benefits

Encourages Walking: Reduces reliance on cars, promoting health and sustainability.

Improves Equity: Identifies areas where people lack immediate access to services, guiding targeted improvements.

Quick Emergency Response: Useful for emergency planning-ensures rapid access to shelters or exits.

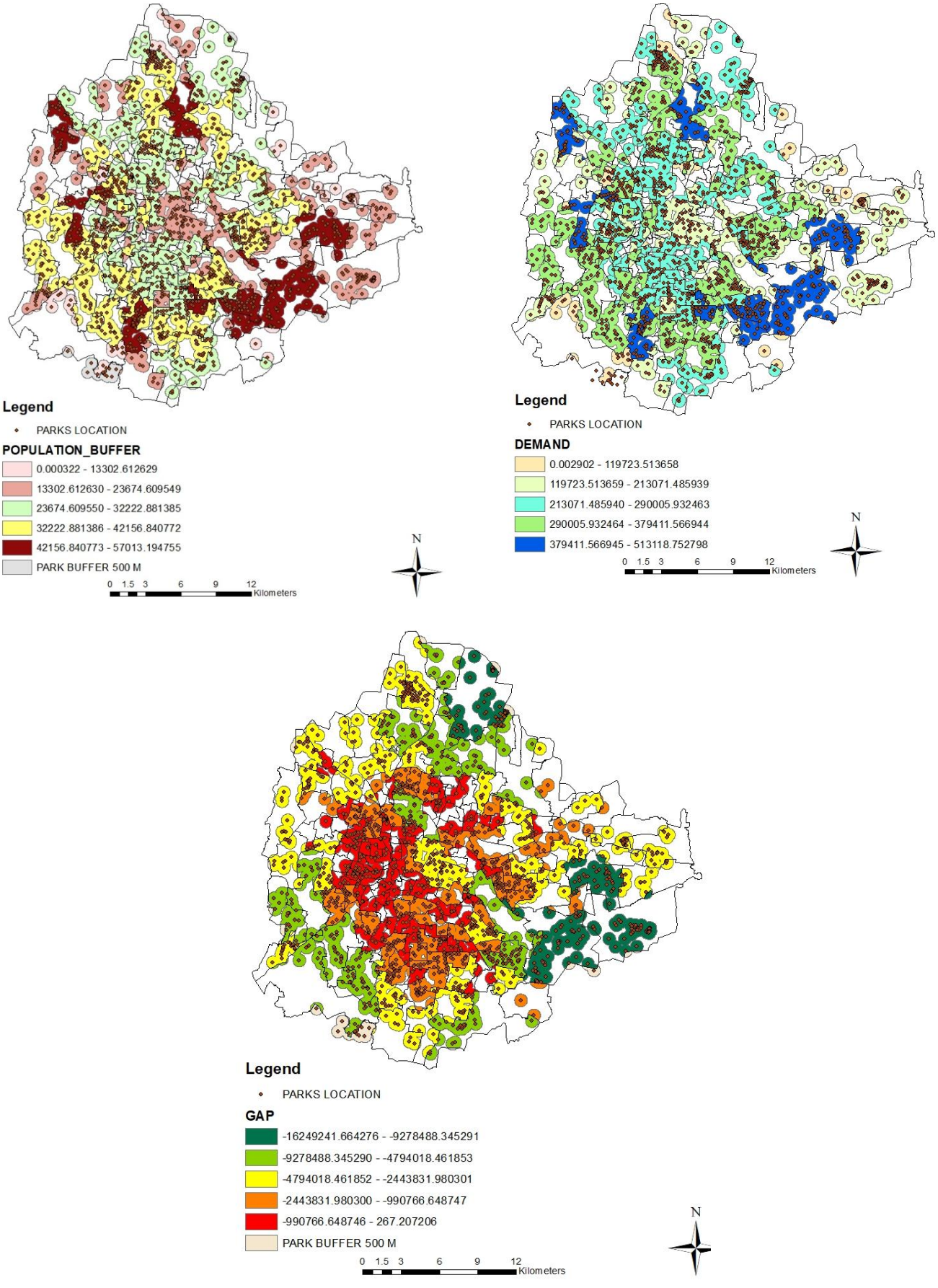

Legend
PARKS LOCATION
POPULATION_BUFFER
0.000322 - 13302.612629
13302.612630 - 23674.609549
23674.609550 - 32222.881385
32222.881386 - 42156.840772
42156.840773 - 57013.194755
PARK BUFFER 500 M
0 1.5 3 6 9 12
Kilometers
N
Legend
PARKS LOCATION
DEMAND
0.002902 - 119723.513658
119723.513659 - 213071.485939
213071.485940 - 290005.932463
290005.932464 - 379411.566944
379411.566945 - 513118.752798
0 1.5 3 6 9 12
Kilometers
N
Legend
PARKS LOCATION
GAP
-16249241.664276 - -9278488.345291
-9278488.345290 - -4794018.461853
-4794018.461852 - -2443831.980301
-2443831.980300 - -990766.648747
-990766.648746 - 267.207206
PARK BUFFER 500 M
0 1.5 3 6 9 12
Kilometers
N

Figure 19

Park Accessibility: The coverage of the 500m buffer, surrounding parks, is comparatively small. The buffer is only included in the near vicinity of the parks.

Population Coverage: A large number of populous locations are outside the 500m park borders, particularly the portions shaded in dark (which denotes a higher population density).

Service Gaps: A park is 500 meters away from a lot of parts of the city, especially in the outside and some core regions.

Only parks with overlapping buffers in areas with a high population density are easily accessible to a sizable section of the populace. Fewer individuals within a 500-meter radius are served by parks in less populated or outlying locations.

Restricted Accessibility: There is limited park accessibility at 500m. Easy access is only available to residents who live extremely close to parks (within a 5–7 minute walk).

Equity Concern: Many densely populated neighbourhoods are underserved at this distance, and there are obvious gaps in park accessibility.

Only parks located in or near densely populated areas are accessible to a significant number of people. Many parks, especially those in less dense or peripheral areas, serve fewer residents within this range.

4.2.2 Buffer Analysis for 800 M

Moderate Walking Distance: 800 meters is about a 10–12 minute walk, often considered a reasonable distance for most people to reach transit stops or community facilities.

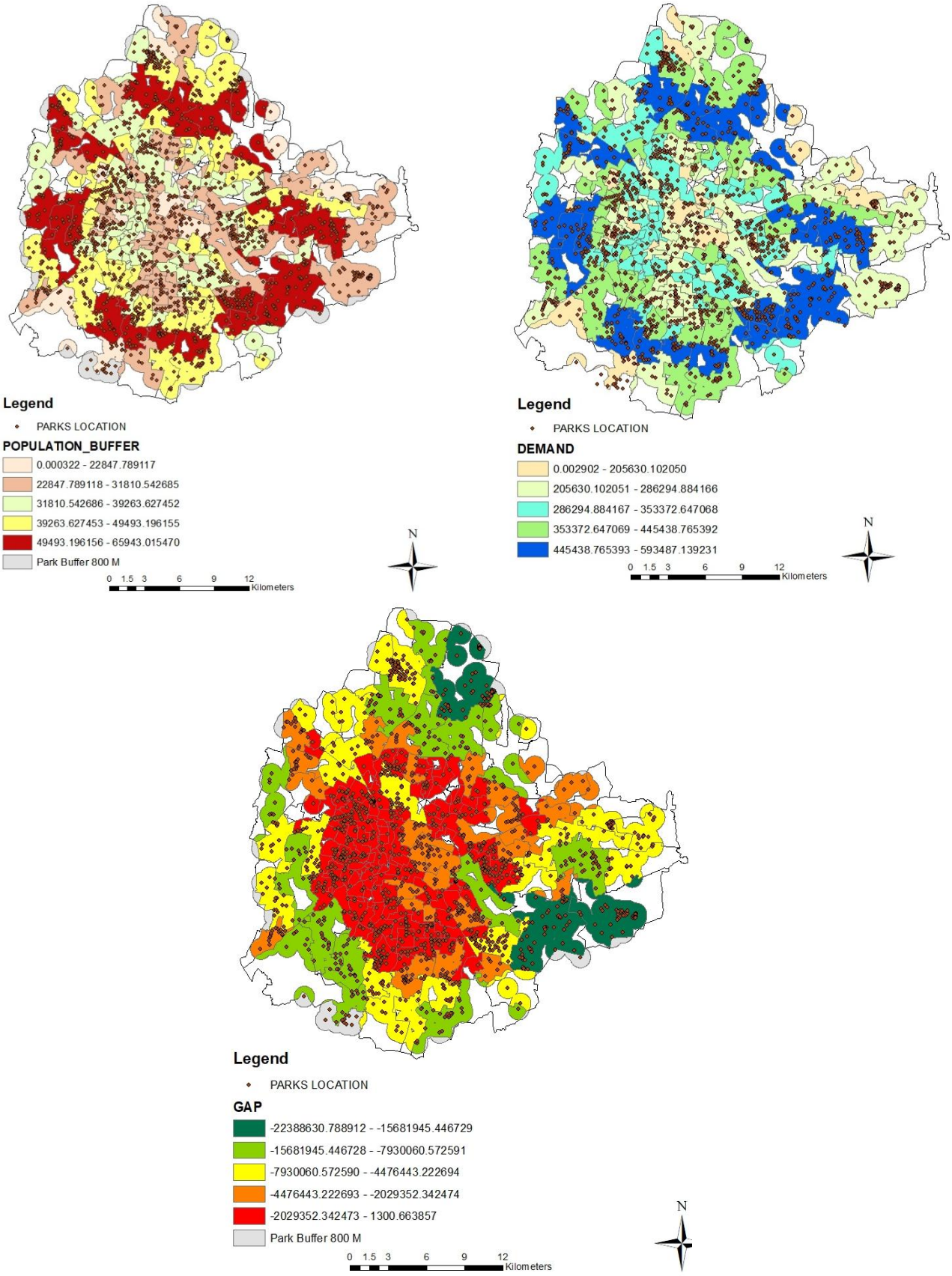
Broader Accessibility: Captures a wider area, showing the full extent of a service's reach.

Benefits

Maximizes Service Impact: Ensures more people are served by each facility.

Supports Sustainable Growth: Guides higher-density development near major services or transit.

Reduces Service Gaps: Highlights larger underserved areas that may not be apparent with smaller buffers.


Legend
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POPULATION_BUFFER
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22847.789118 - 31810.542685
31810.542686 - 39263.627452
39263.627453 - 49493.196155
49493.196156 - 65943.015470
Park Buffer 800 M
0 1.5 3 6 9 12
Kilometers
N
Legend
PARKS LOCATION
DEMAND
0.002902 - 205630.102050
205630.102051 - 286294.884166
286294.884167 - 353372.647068
353372.647069 - 445438.765392
445438.765393 - 593487.139231
0 1.5 3 6 9 12
Kilometers
N
Legend
PARKS LOCATION
GAP
-22388630.788912 - -15681945.446729
-15681945.446728 - -7930060.572591
-7930060.572590 - -4476443.222694
-4476443.222693 - -2029352.342474
-2029352.342473 - 1300.663857
Park Buffer 800 M
0 1.5 3 6 9 12
Kilometers
N

Figure 20

Park Accessibility: The 800m buffer (gray shaded areas) covers a much larger portion of the city. The buffers are more extensive and overlap more, especially in central and moderately populated areas.

Population Coverage: A significantly higher proportion of the population, including those in previously underserved areas, now falls within the buffer zones.

Service Gaps Reduced: While some peripheral and high-density areas still remain outside the 800m buffer, the gaps are much smaller compared to the 500m scenario.

Parks Accessible: More parks are accessible to a larger number of people, as the buffer zones now encompass more residential zones.

Improved Accessibility: At 800m, park accessibility improves substantially. Many more residents can reach a park within a 10–12 minute walk.

Better Coverage: The city achieves broader and more equitable coverage, though a few gaps still exist, especially in the outermost and densest areas.

Most parks become accessible to a much larger segment of the population. Overlapping buffers mean that some residents may have access to multiple parks within 800m, increasing options and flexibility.

Buffer Distance	Population Coverage	Park Accessibility	Service Gaps
500m	Low	Limited (mostly for nearby residents)	Many, especially in high-density and peripheral areas
800m	High	Broad (most parks accessible to more people)	Fewer, but some remain in outer/dense areas

Table 12

500m buffer: Good for assessing immediate, local access; reveals many underserved areas.

800m buffer: Shows improved, more equitable access; most parks become reachable for a majority of the population.

4.3 Demand Supply and Gap Identification

Total Population is 8443675

Total Park Area is 13393590.11

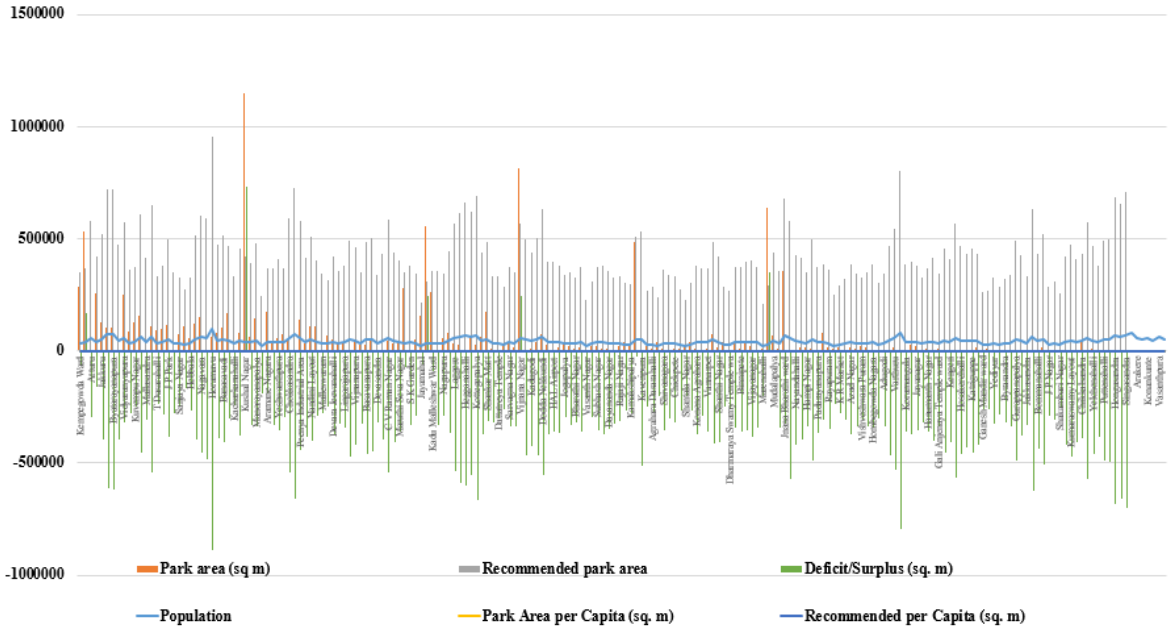


Figure 21

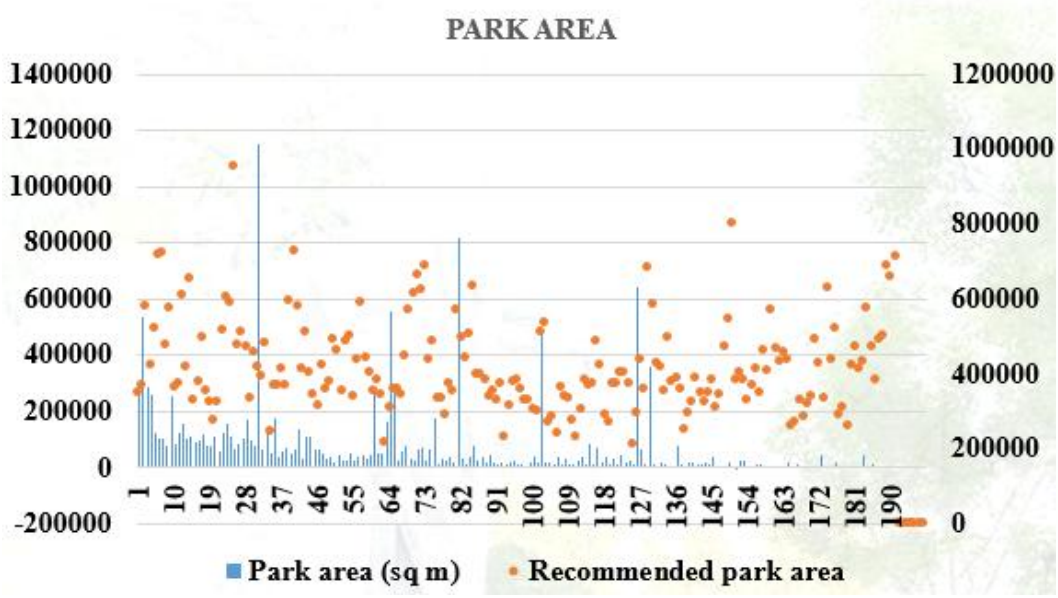


Figure 22

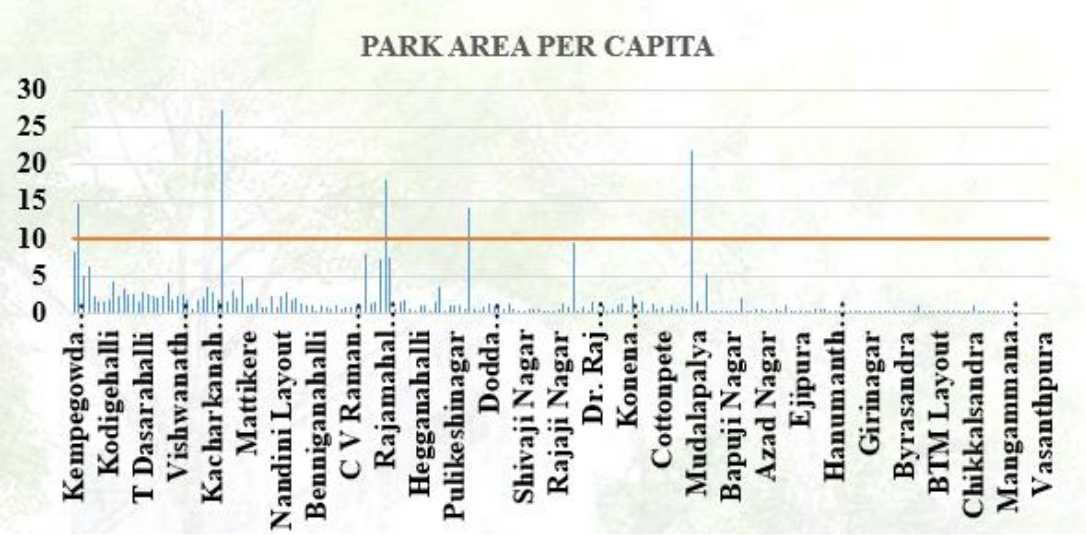


Figure 23

Average park area per capita across Bangalore is only **1.59 sq. m**, far below the recommended 10 sq. m per person.

Average deficit per ward is **-358,694 sq. m.**

Out of 198 wards, **193** have a deficit and only **5** have a surplus.

1.58 which is the average park area per person across the whole city.

7 wards have zero park area: Begur, Arakere, Gottigere, Konankunte, Anjanapura, Vasanthpura, Hemmigepura.

These wards have a combined population of over 400,000, meaning a huge number of residents have no formal access to parks at all.

Each of these wards shows a deficit exactly equal to their recommended park area (e.g., Begur: -800,370 sq. m).

Horamavu has the highest deficit: -890,182 sq. m, with a population of 95,368 and only 63,498 sq. m of park area.

Other top deficit wards include Begur, Bellanduru, Singasandra, Hongasandra, Kottegepalya, Dodda Bidarakallu, Mangammanapalya all with deficits above -650,000 sq. m.

Only 5 wards have a surplus (more park area than recommended), with the highest surplus in Kushal Nagar (+730,741 sq. m) and Rajamahal Guttahalli (+244,502 sq. m).

4.4 Ward-Wise Park Area Distribution Analysis

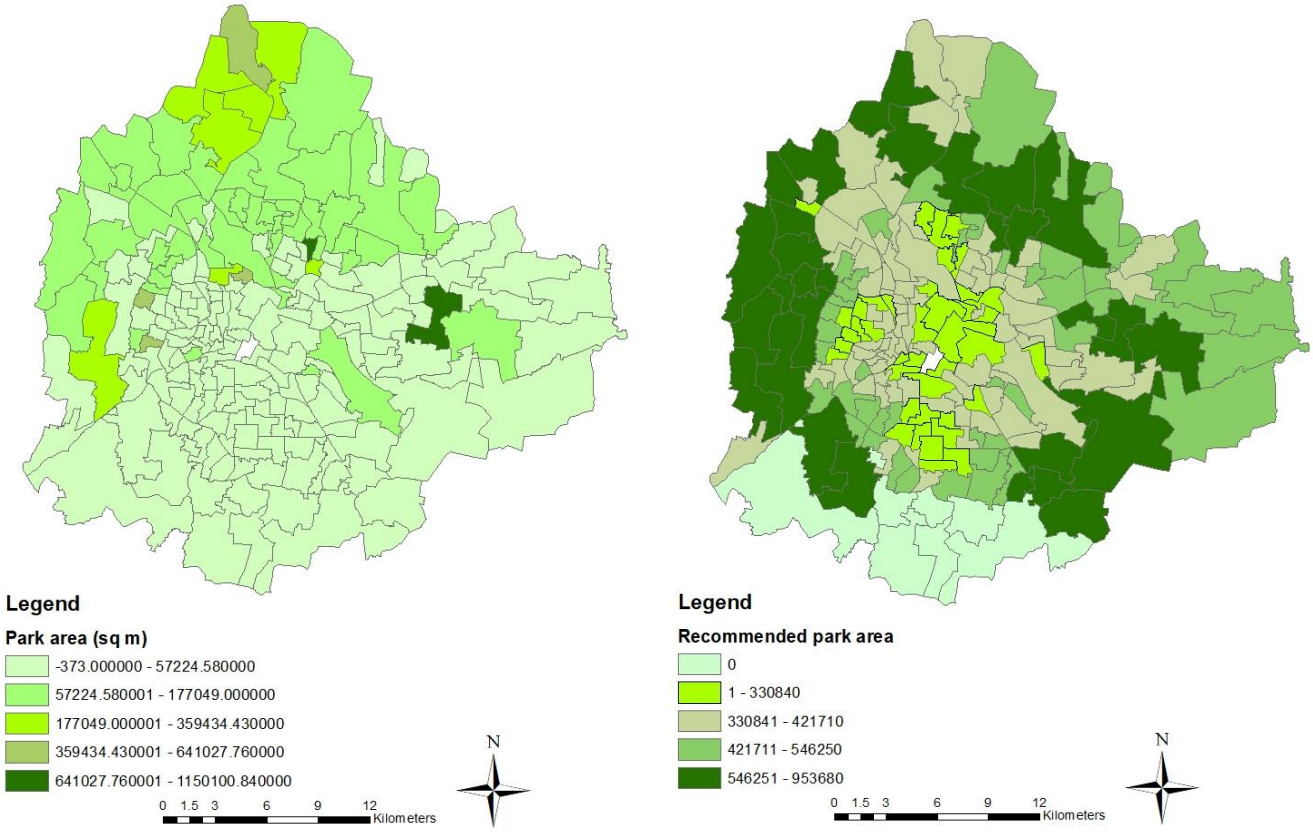


Figure 24

Bommanahalli has the highest area under parks at 39.13 sq.m.

Nandini Layout has the lowest area under parks at 0.036 sq.m.

Wards meeting the standard of open spaces:

1. Pattabhiram Nagar: 9.63 sq.m

2. Rajarajeshwari Nagar: 10.04 sq.m

3. Singasandra: 10.11 sq.m

4. Puttenahalli: 10.47 sq.m

Some wards have no park area, which is significantly below the standard. These include Begur, Arakere, Gottigere, Konankunte, Anjanapura, Vasanthpura and Hemmigepura.

There's a considerable range in park area across wards, indicating unequal distribution of green spaces.

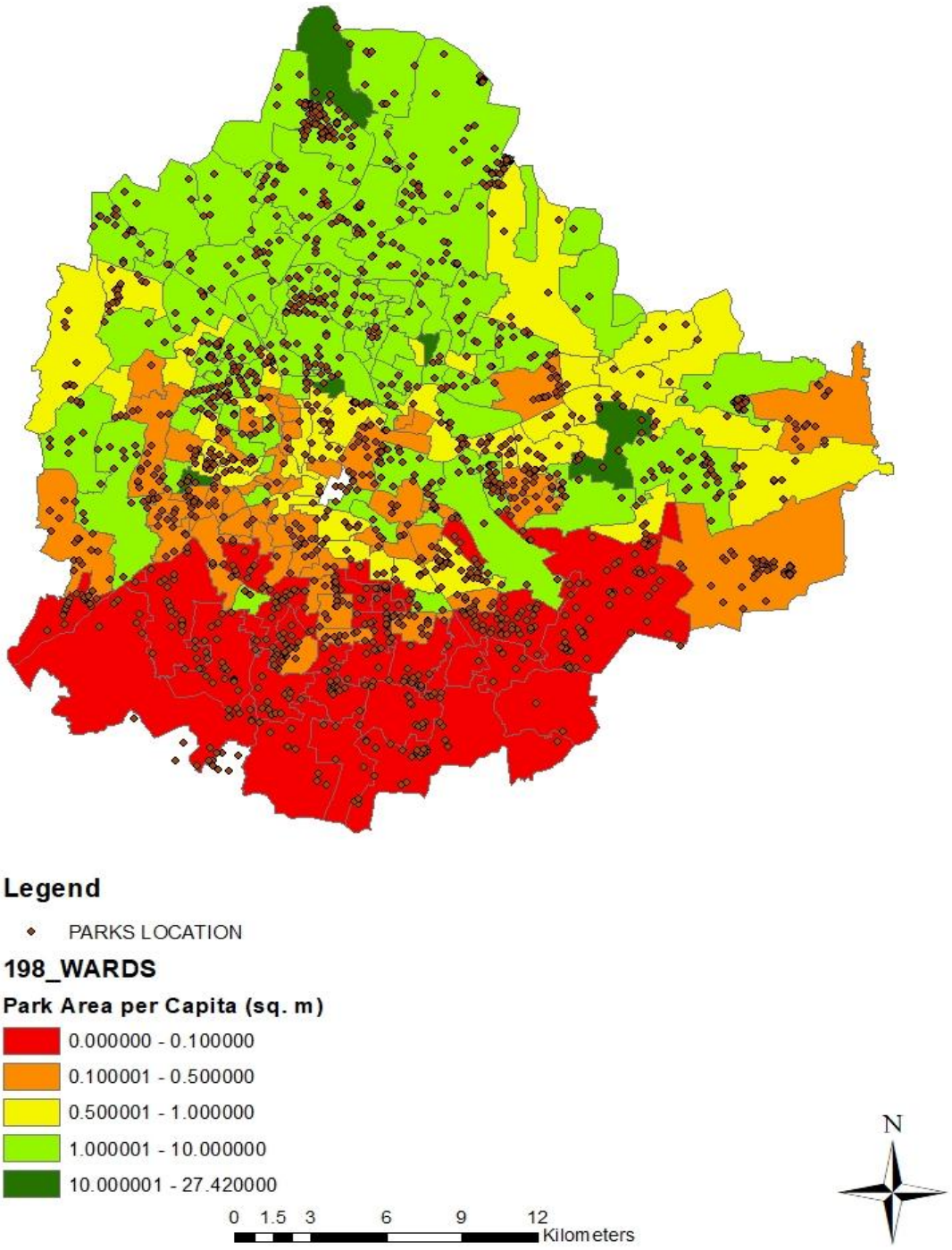


Figure 25

4.5 Analysis through Satellite Imagery

Parameter	Definition/What It Measures	If Parameter Increases	Effect on Open Spaces	If Parameter Decreases	Effect on Open Spaces
NDVI	Density and health of vegetation	More/healthier vegetation	Enhances ecological value, cooling, air quality, and biodiversity; supports microclimate regulation and recreational use.	Less/weaker vegetation	Reduces ecological value, increases urban heat, worsens air quality, and decreases biodiversity.
NDBI	Extent of built-up/urbanized areas	More built-up land, less green/open space	Reduces open space, increases urban heat island effect, decreases biodiversity, and worsens air quality.	Less built-up land, more green/open space	Preserves or expands open spaces, reduces urban heat, improves biodiversity and air quality.
NDWI	Presence/extent of water bodies	More/healthier water bodies	Improves microclimate, groundwater recharge, biodiversity, and recreational value; mitigates urban heat.	Fewer/less healthy water bodies	Reduces microclimate benefits, biodiversity, and recreational value; increases urban heat.
LST	Land surface temperature	Hotter surfaces	Indicates loss/degradation of open spaces and vegetation; increases discomfort, reduces	Cooler surfaces	Indicates healthier open spaces with more vegetation, improves usability, and

			usability, and worsens urban heat island effect.		reduces urban heat island effect.
Air Pollution	Concentration of pollutants (PM2.5, NO_2, etc.)	Higher pollutant levels	Reduces health benefits and usability of open spaces; linked to loss of vegetation and green cover.	Lower pollutant levels	Improves health benefits and usability of open spaces; linked to healthier vegetation and green cover.
VCI	Health and stress level of vegetation	Healthier, less stressed vegetation	Increases resilience and ecosystem services of open spaces; supports biodiversity and microclimate.	More stressed vegetation	Reduces resilience and ecosystem services; open spaces provide fewer benefits and are less able to support biodiversity.
SI (Shadow Index)	Density of built structures (based on shadows)	Denser construction, less open space	Reduces accessibility, usability, and thermal comfort of open spaces; increases local temperatures.	Less dense construction, more open space	Improves accessibility, usability, and thermal comfort; open spaces become more usable and pleasant.

Table 13

Formulas of different parameters used for generating maps through satellite imagery

INDICES (LANSAT IMAGERY 8)	FORMULA USED	Purpose
Normalized Difference Land Surface Temperature (LST)	Lλ=ML*Band 10=AL-Qi, where Lλ=0.0003342, AL-Qi= 0.10000-0.29 BT=k2/Ln(K1/Ln=1)-273.15, where k2= 1321.0789, k1= 774.8853 NDVI= (Band 4 – Band 3) / (Band 4 + Band 3) PV= ((NDVI - NDVI min) / (NDVI max - NDVI min))2 E= 0.004* PV+ 0.986 LST= BT/(1+(λ*BT/C2)*Ln(E))	Monitoring temperature changes and evaluating the effects of human activity on the environment are made possible by this crucial indicator of the city's surface temperature, climatic patterns, and other environmental processes.

Table 14

INDICES (LANSAT IMAGERY 8)	FORMULA USED	Purpose
Normalized Difference Vegetation Index (NDVI)	(Band 4 – Band 3) / (Band 4 + Band 3)	This is a prominent indicator used for identifying vegetation. A higher NDVI index score suggests more vegetation on the ground, negative NDVI index value denotes non-green areas such as barren, sea, river, and built-up areas, and a positive value represents green areas.
Normalized Difference Built-up Index(NDBI)	(Band 6 – Band 5) /(Band 6+ Band 5)	Used to identify and analyse built-up areas.
Normalized Difference Water Index (NDWI)	(Band 3 – Band 5) / (Band 3 + Band 5)	Used to delineate and monitor water bodies and assess water content in vegetation.
Vegetation Condition Index (VCI)	100 * (NDVI - NDVI min) / (NDVI max - NDVI min)	Monitoring environmental health, detecting drought and other stressors, assessing land cover changes.
Shadow Index (SI)	((1-Band 2)* (1-Band 3)* (1-Band 4))* (1.0/3.0)	Used to identify and examine shadows, which are important for precise vegetation mapping, land cover interpretation, and other geospatial analysis.

Table 15

4.5.1 Air Quality Index

Air Quality Index (AQI) maps are created in GIS to visualize, analyze, and manage air pollution data spatially and temporally.

Bengaluru is taking steps to address the primary causes of air pollution and is one of 48 cities that have signed the "Clean Air Accelerator." The city intends to use this accelerator to prioritize air quality by creating a wide range of high-impact initiatives, such as electrifying bus fleets, establishing low-emission zones, extending air pollution monitoring networks, and moving away from polluting fuels for heating. Indoor air pollution can only be assessed using household fuel and housing type data, but outdoor air pollution is tracked by national missions and sensors.

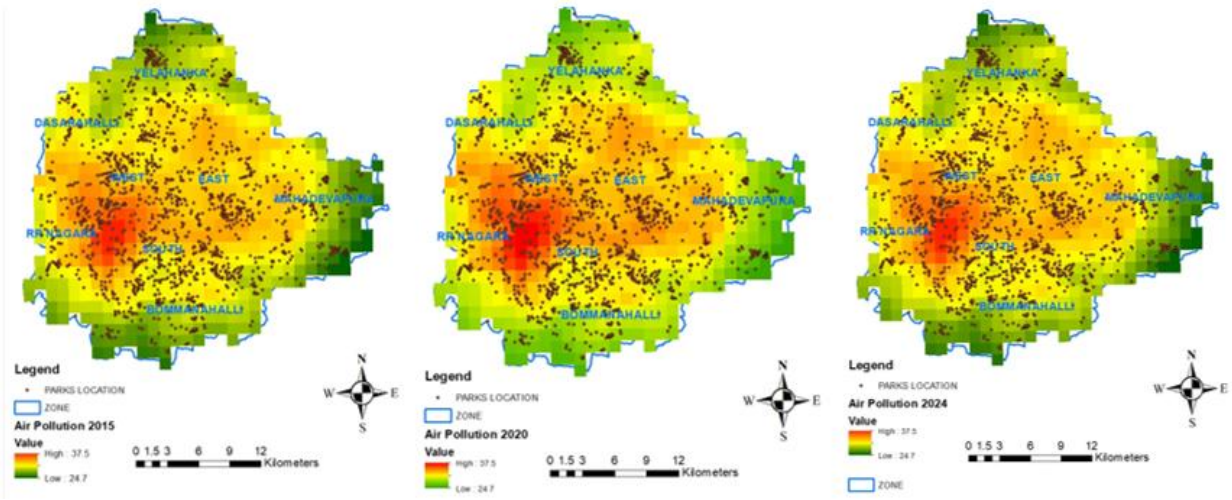


Figure 26

From figure 26 we can say that the maps reveal a consistent pollution pattern across all three time periods, with a distinct hotspot of high pollution in the western central part of the city. The persistent hotspot in the western central area likely corresponds to a major industrial zone or commercial district with concentrated emissions sources. The central areas typically experience heavier traffic volumes than peripheral regions, explaining the higher pollution levels in the core areas.

4.5.2 Land Surface Temperature (LST)

Since 1975, the average air temperature in Bengaluru has increased by 0.23°C per ten years, or 0.023°C annually. At over half a degree every decade, the increase has been more pronounced in the past ten years. An protracted period of hot weather compared to the typical circumstances in the area during that time of year is called a heat wave. The average nighttime LST has risen by more than 1.5°C over the past 20 years, indicating a growing disparity between urban and rural areas. Areas like Peenya, Hebbal, and Nagarabhavi on the outskirts, as well as Chikkapete (a congested ancient core city region), have higher LSTs of roughly 35–36°C, whereas well-planned residential layouts like Jayanagar, Koramangala, and Indiranagar have comparatively lower LSTs (usually between 32–33°C).

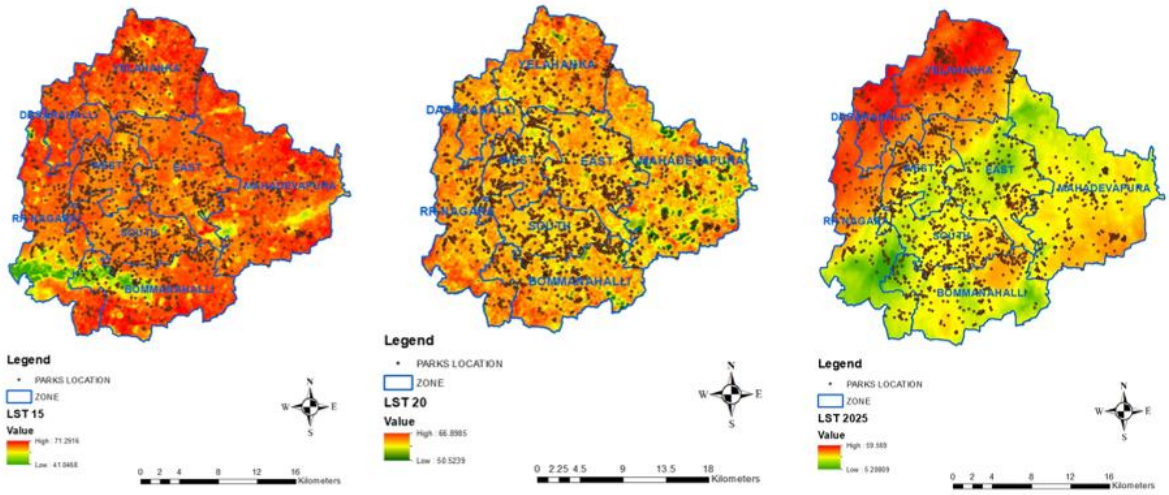


Figure 27

From figure 27 we can say that in 2015, it indicates uniformly high surface temperatures with only isolated small green patches in Bommanahalli zone. In 2020 there is slightly greater temperature variability and small scattered green areas and in 2025 there is dramatic shift showing a distinct east-west divide, with western areas (Yelahanka, Dasarahalli, RR Nagara) remaining hot while eastern and southern zones show significantly cooler temperatures. Western Zones (Yelahanka, Dasarahalli, RR Nagara) consistently hot across all three time periods. Eastern Zones (East, Mahadevapura) progressive cooling trend. Southern Zones (South, Bommanahalli) moderate temperatures in 2015-2020, with significant cooling by 2025.

4.5.3 Normalized Difference Vegetation Index (NDVI)

This is a prominent indicator used for identifying vegetation. A higher NDVI index score suggests more vegetation on the ground, negative NDVI index value denotes non-green areas such as barren, sea, river, and built-up areas, and a positive value represents green areas. From figure 28 we can say that areas like the Bannerghatta National Park and surrounding forests (Southern part) showed high NDVI values (0.7-1.0), indicating dense, healthy vegetation. Central Bangalore had lower NDVI values (0.3-0.5), reflecting moderate vegetation cover amidst urban development. In 2025, western and central areas continued to show lower NDVI values due to ongoing urban development and increased slightly in eastern and southern zones due to urban forestry initiatives and green infrastructure projects.

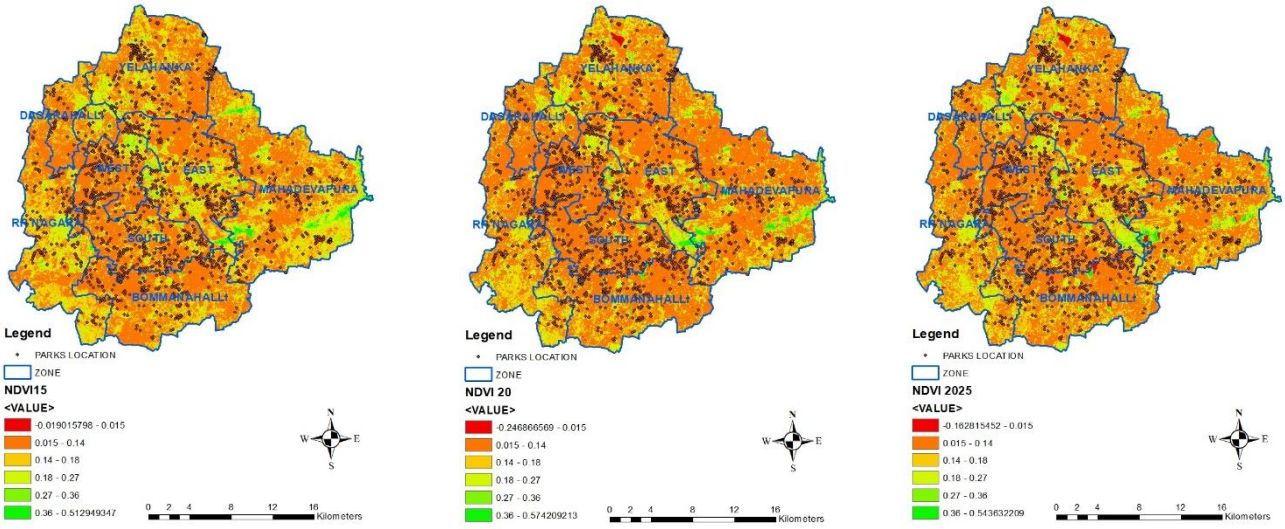


Figure 28

4.5.4 Vegetation Condition Index (VCI)

Monitoring environmental health, detecting drought and other stressors, assessing land cover changes. From figure 23 we can say that in 2015 there was high VCI scores in south area with lush vegetation, indicating good vegetation health, while central zone had lower vci scores and in western zones vci was moderate.In 2020, urban expansion and environmental stressors led to a decrease in VCI across most zones. The southern zone still maintained relatively higher VCI due to its natural reserves, but urbanization around these areas began to impact vegetation health. In 2025, eastern and southern zones showed slight improvements in VCI. The eastern zone, particularly around Whitefield and Varthur, saw increased focus on green spaces and lake restoration, contributing to better vegetation health.

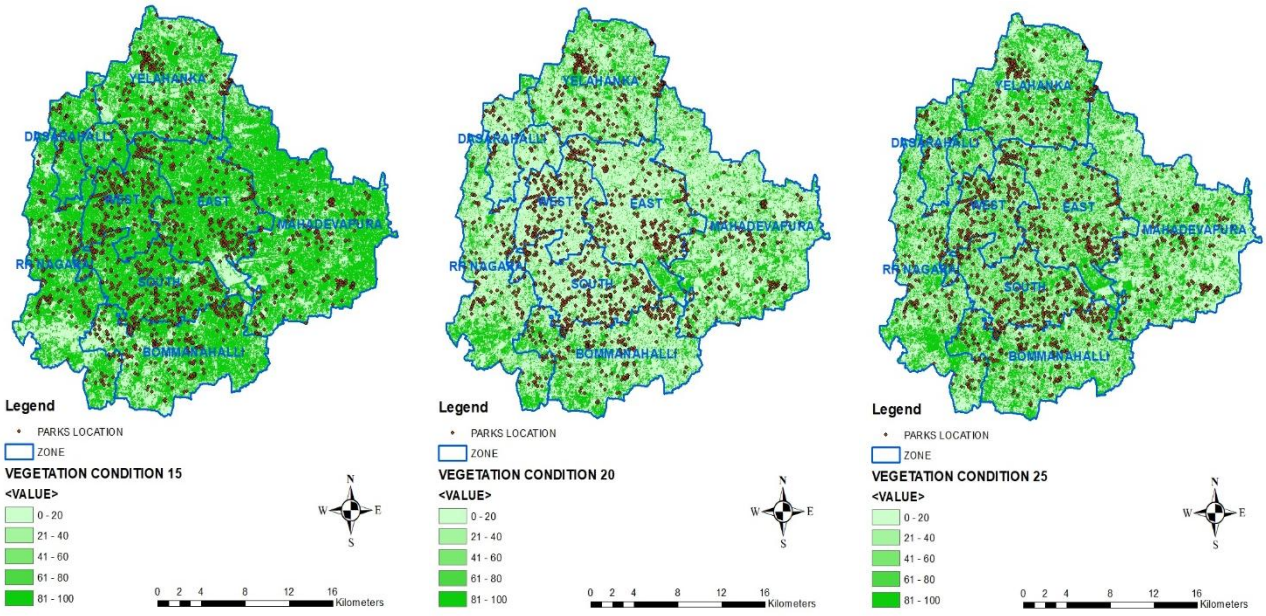


Figure 29

4.5.5 Normalized Difference Built-up Index (NDBI)

Used to identify and analyze built-up areas. From figure 23 we can say that in 2015, NDBI values were high in central and western zones, reflecting extensive built-up areas. Areas like Electronic City and Whitefield showed significant urban development. In 2020, NDBI increased across all zones, particularly in eastern areas like Varthur and Bellandur, where rapid urbanization led to more built-up spaces, major infrastructure projects, such as the Peripheral Ring Road and Metro expansions, contributed to higher NDBI values. In 2025, NDBI remained high across the city, with further expansion into previously rural areas. However, some areas showed stabilization due to saturation of urban development.

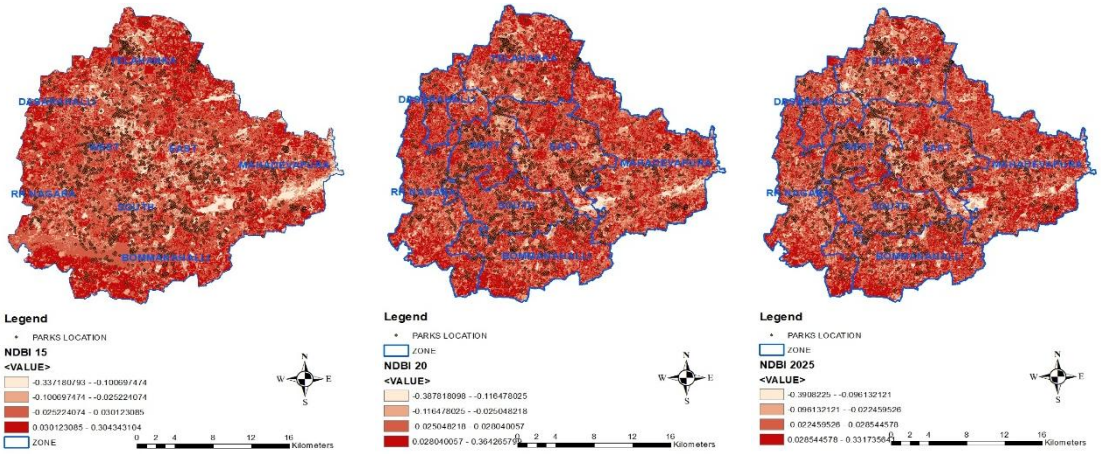


Figure 30

4.5.6 Normalized Difference Water Index (NDWI)

Used to delineate and monitor water bodies and assess water content in vegetation. From figure 25 we can say that in 2015, NDWI values were high around major lakes and water bodies, indicating healthy water cover. Areas like Ulsoor Lake and Sankey Tank showed significant water presence. In 2020, NDWI decreased due to encroachment and pollution of lakes, particularly in areas like Bellandur and Varthur. In 2025, Enhanced conservation efforts led to slight improvements in NDWI for certain lakes and water bodies, particularly in eastern zones. Increased focus on water-sensitive urban design helped stabilize NDWI values in areas with integrated water management systems.

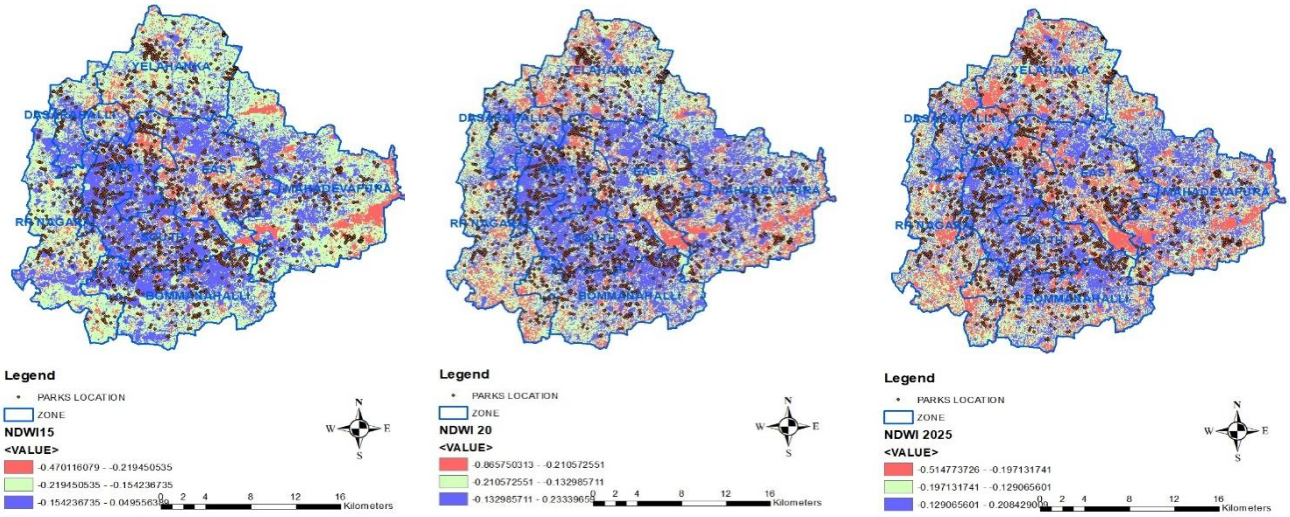


Figure 31

4.5.7 SI (Shadow Index)

Used to identify and examine shadows, which are important for precise vegetation mapping, land cover interpretation, and other geospatial analysis. From figure 26 we can say that in 2015, the central zone shows moderately high SI values, indicating substantial shadowing due to buildings. Green areas reflect lower shadowing in parks or less dense vegetated areas. Central Zone moderate to High SI. East Zone (Mahadevapura) moderate SI, with pockets of lower SI. South Zone (Bommanahalli), mix of moderate and low SI, showing green spaces.Yelahanka moderate SI. In 2025, Central Zone high SI, with more pronounced shadowing East Zone (Mahadevapura) increase in SI, indicating more buildings South Zone (Bommanahalli) gradual increase in SI, with loss of some green areas Yelahanka increase in SI, signaling more urban development.

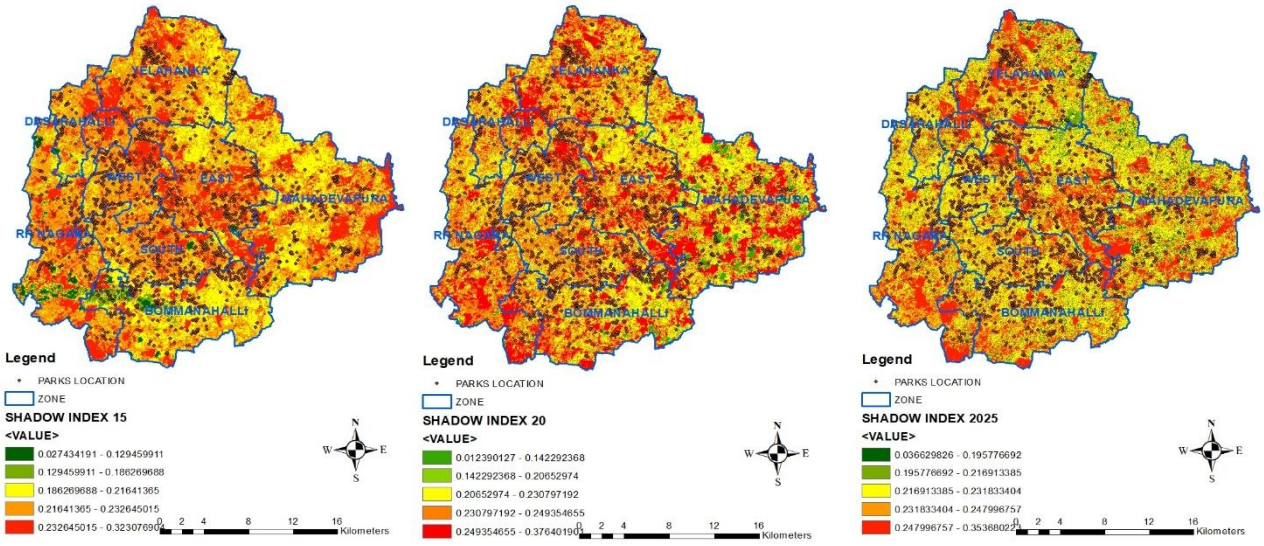
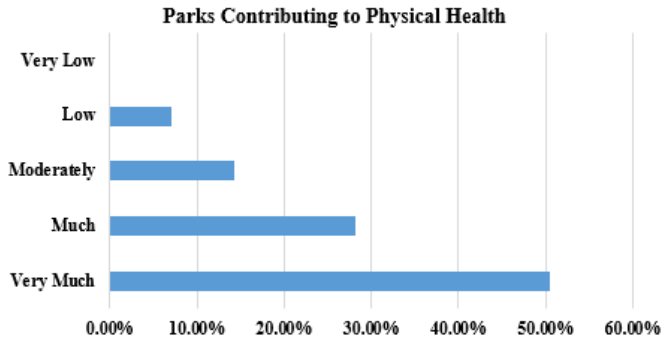


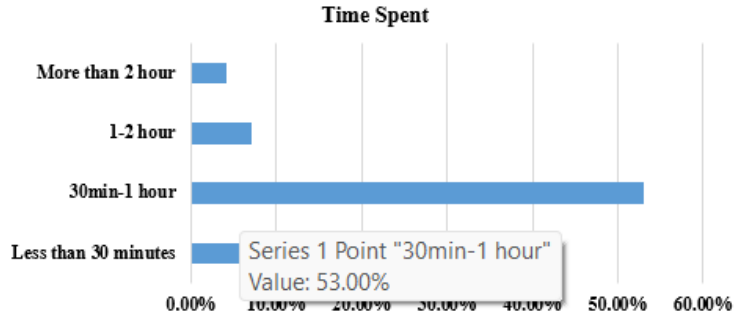
Figure 32

4.6 Analysis of Field Survey

For the responses the survey questions were divided based on quality of life dimensions like Physical Health Indicators, Mental Health Indicators, Social Interaction Indicators, Environmental Indicators, Infrastructure Facilities Indicators.

Physical Health Indicators





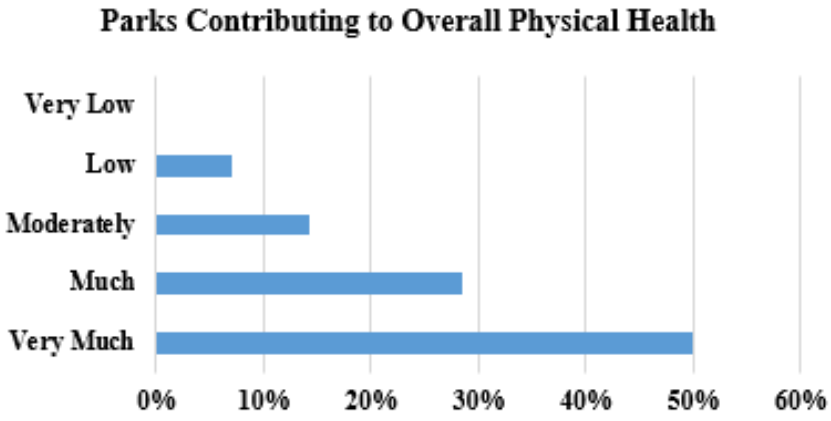


Figure 33

Mental Health Indicators

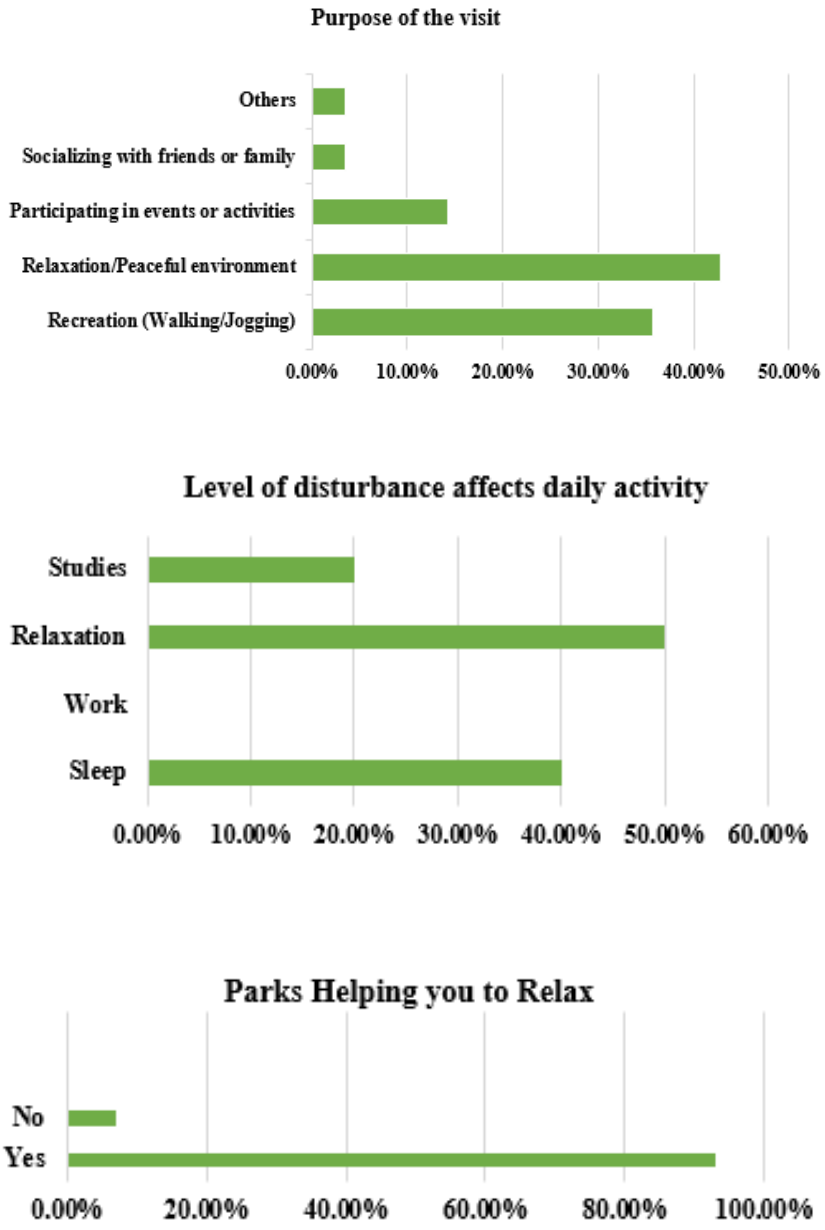


Figure 34

Social Interaction Indicators

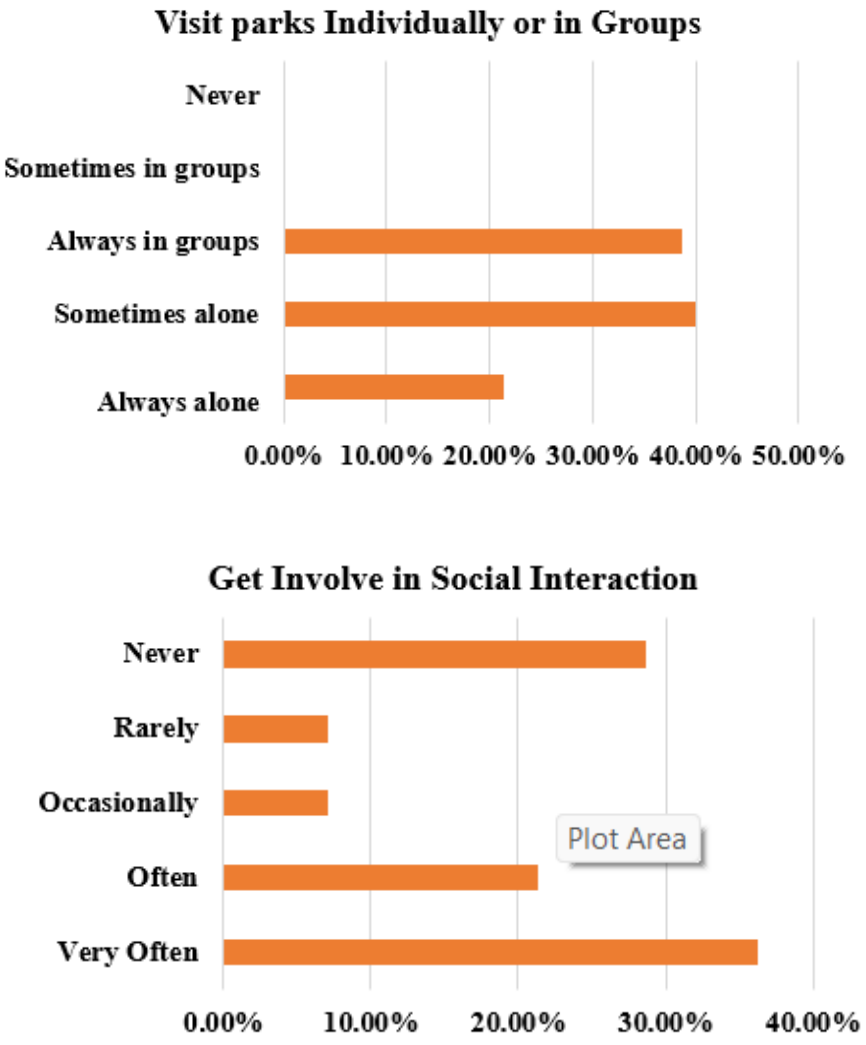


Figure 35

Environmental Factors

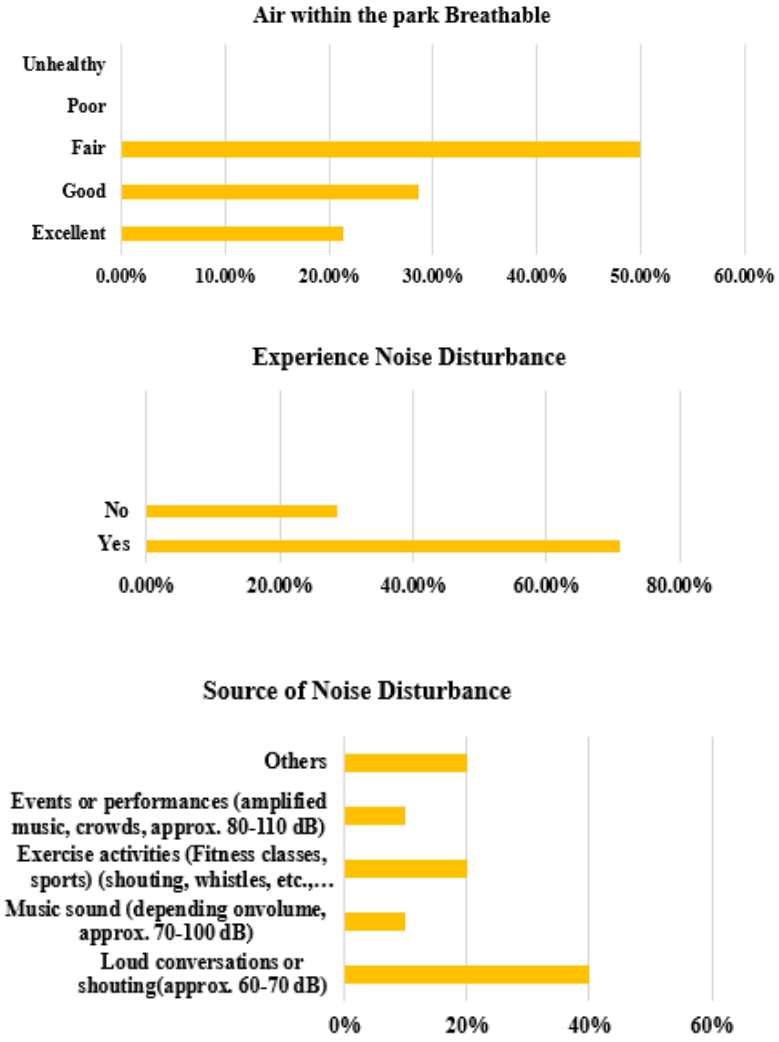


Figure 36

Infrastructure Facilities

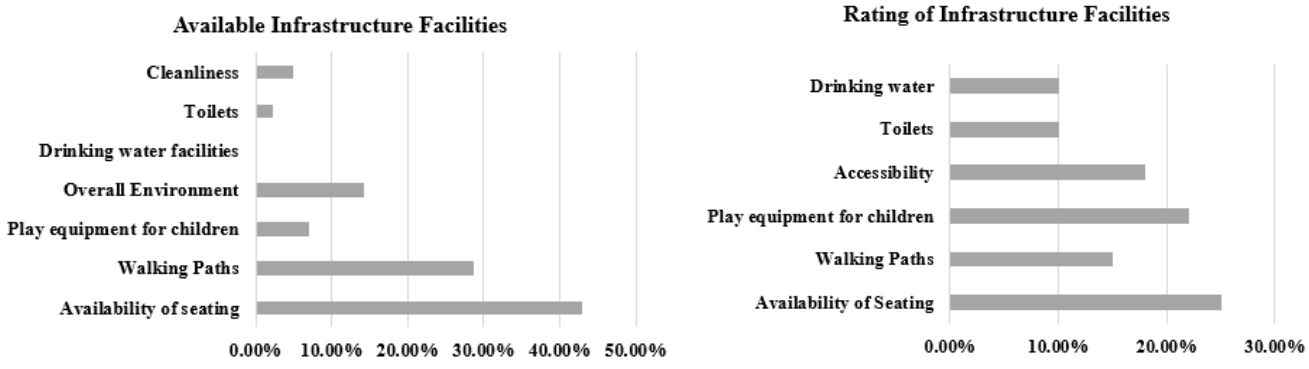


Figure 37

Overall Impact on Quality of Life

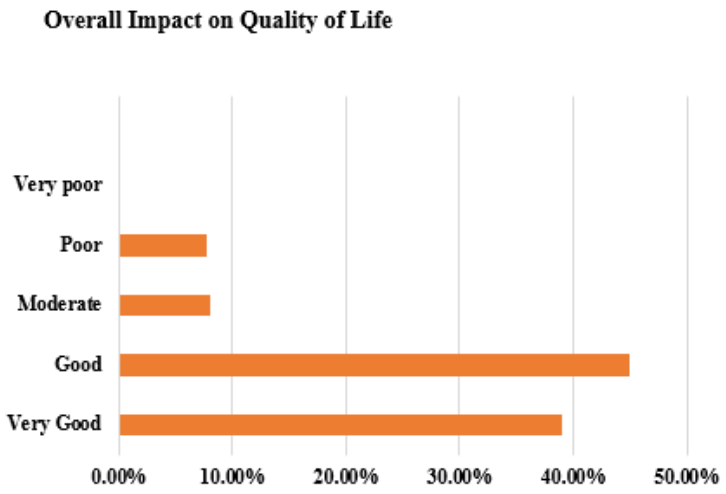


Figure 38

A majority of respondents (75–85%) report that access to parks improves their physical and mental health. Respondents who visit parks more frequently report higher levels of community belonging and social interaction. More number of people are involved in physical activities like walking, jogging and also interaction and relaxation which shows that open spaces can improve quality of life. Over 80% of respondents indicate that spending time in parks helps reduce stress and anxiety, providing a sense of relaxation and mental restoration. Over 70% respondents agree that parks and green spaces contribute to improved air quality and help mitigate the urban heat island effect. Only about half of respondents rate cleanliness and maintenance as good or very good. Only 10% toilet facilities are in good condition among all the parks. There is only 1-2% drinking facilities in the parks. About 75% claim that their lifestyle is being affected due to the noise disturbance they are facing from nearby parks. Only 20 % responders claim that the air quality within the park is excellent. Around 40-45% responders say that parks can affect quality of life in a positive way.

4.7 Quality of Life Scores

Zone	NDVI	VCI	SI	NDBI	Air Quality	LST	NDWI	Pop. Density	QOL Score	QOL Level
Yelahanka	0.79	0.79	0.75	0.38	0.60	0.53	0.83	0.50	0.68	Moderate
South	0.71	0.71	0.67	0.25	0.50	0.40	0.75	0.35	0.57	Moderate
West	0.69	0.69	0.63	0.20	0.45	0.33	0.72	0.25	0.53	Moderate
East	0.64	0.64	0.58	0.13	0.40	0.27	0.67	0.15	0.48	Low
RR Nagara	0.74	0.74	0.70	0.30	0.55	0.47	0.80	0.40	0.63	Moderate
Mahadevapura	0.57	0.57	0.50	0.05	0.30	0.13	0.58	0.05	0.41	Low
Dasarahalli	0.67	0.67	0.62	0.18	0.42	0.30	0.70	0.20	0.52	Moderate
Bommanahalli	0.61	0.61	0.53	0.10	0.35	0.20	0.63	0.10	0.46	Low

Table 16

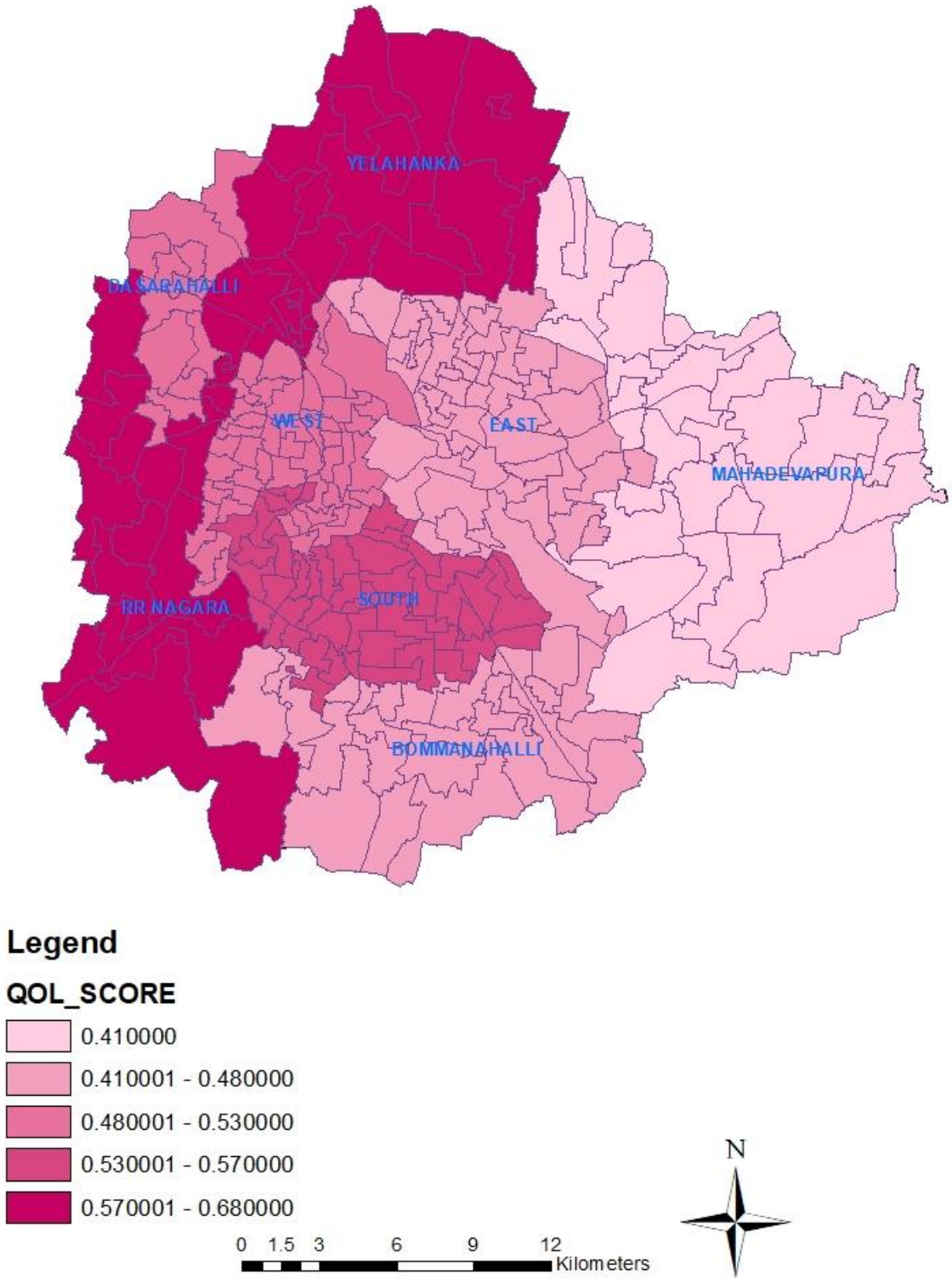

YELAHANKA
DASARAHALLI
WEST
EAST
MAHADEVAPURA
RR NAGARA
SOUTH
BOMMANAHALLI
Legend
QOL_SCORE
0.410000
0.410001 - 0.480000
0.480001 - 0.530000
0.530001 - 0.570000
0.570001 - 0.680000
0 1.5 3 6 9 12
Kilometers
N

Figure 39

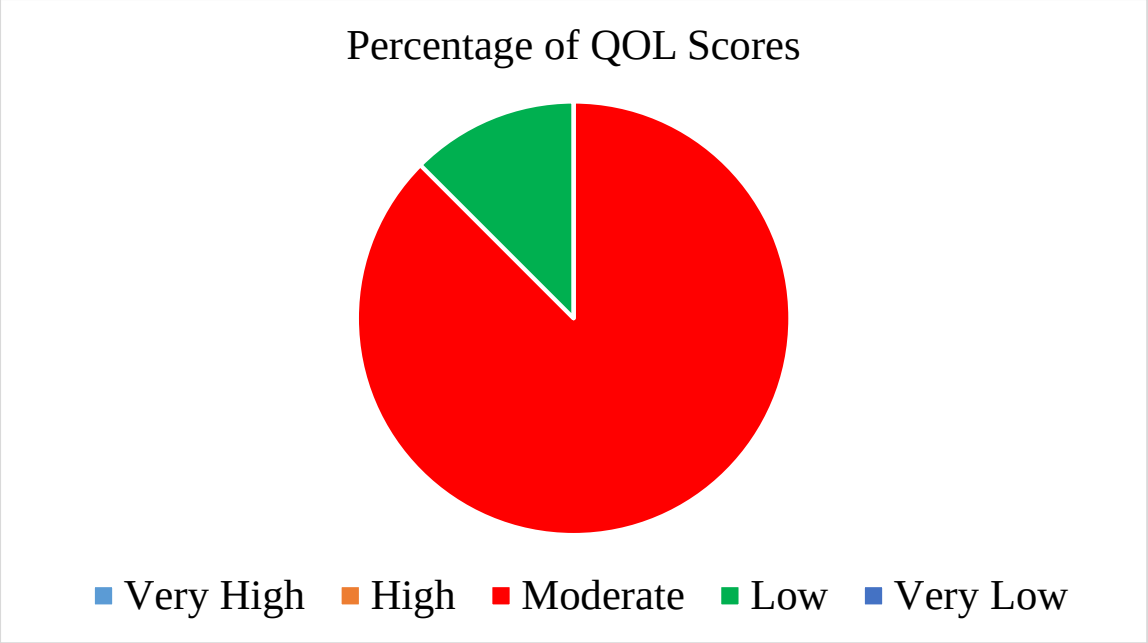


Figure 40

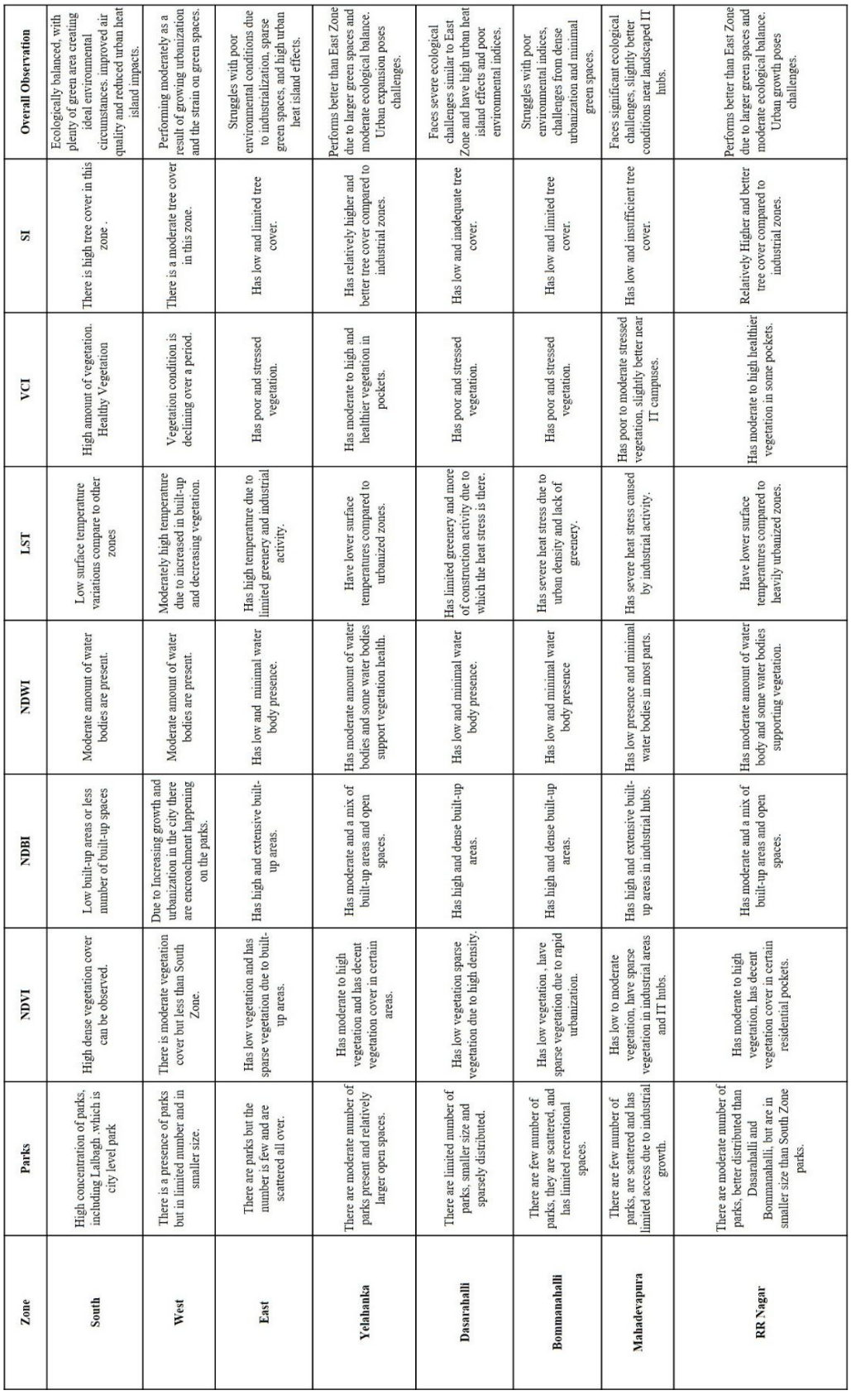
No Zone Reaches high or very high Quality of Life.

From the map we can observe that Mahadevapura zone has low Quality of Life, followed by Bommanahalli and East zone.

And Zone with high Quality of Life is Yelanhanka and RR.Nagara..

Despite Bengaluru's economic success, your QoL analysis reveals that no zone achieves a high quality of life, and Mahadevapura faces significant challenges. This underscores the need for targeted urban planning, especially in areas with low QoL, to address environmental, social, and infrastructure deficits citywide.

4.8 Analysis Zone Wise



Zone	Parks	NDVI	NDBI	NDWI	LST	VCI	SI	Overall Observation
South	High concentration of parks, including Lalbagh, which is city level park	High dense vegetation cover can be observed.	Low built-up areas or less number of built-up spaces	Moderate amount of water bodies are present.	Low surface temperature variations compare to other zones	High amount of vegetation. Healthy Vegetation	There is high tree cover in this zone .	Ecologically balanced, with plenty of green area creating ideal environmental circumstances. improved air quality and reduced urban heat island impacts.
West	There is a presence of parks but in limited number and in smaller size.	There is moderate vegetation cover but less than South Zone.	Due to Increasing growth and urbanization in the city there are encroachment happening on the parks.	Moderate amount of water bodies are present.	Moderately high temperature due to increased in built-up and decreasing vegetation.	Vegetation condition is declining over a period.	There is a moderate tree cover in this zone.	Performing moderately as a result of growing urbanization and the strain on green spaces.
East	There are parks but the number is few and are scattered all over.	Has low vegetation and has sparse vegetation due to built-up areas.	Has high and extensive built-up areas.	Has low and minimal water body presence.	Has high temperature due to limited greenery and industrial activity.	Has poor and stressed vegetation.	Has low and limited tree cover.	Struggles with poor environmental conditions due to industrialization, sparse green spaces, and high urban heat island effects.
Yelahanka	There are moderate number of parks present and relatively larger open spaces.	Has moderate to high vegetation and has decent vegetation cover in certain areas.	Has moderate and a mix of built-up areas and open spaces.	Has moderate amount of water bodies and some water bodies support vegetation health.	Have lower surface temperatures compared to urbanized zones.	Has moderate to high and healthier vegetation in pockets.	Has relatively higher and better tree cover compared to industrial zones.	Performs better than East Zone due to larger green spaces and moderate ecological balance. Urban expansion poses challenges.
Dasarahalli	There are limited number of parks. smaller size and sparsely distributed.	Has low vegetation sparse vegetation due to high density.	Has high and dense built-up areas.	Has low and minimal water body presence.	Has limited greenery and more of construction activity due to which the heat stress is there.	Has poor and stressed vegetation.	Has low and inadequate tree cover.	Faces severe ecological challenges similar to East Zone and have high urban heat island effects and poor environmental indices.
Bommanahalli	There are few number of parks. they are scattered, and has limited recreational spaces.	Has low vegetation , have sparse vegetation due to rapid urbanization.	Has high and dense built-up areas.	Has low and minimal water body presence	Has severe heat stress due to urban density and lack of greenery.	Has poor and stressed vegetation.	Has low and limited tree cover.	Struggles with poor environmental indices, challenges from dense urbanization and minimal green spaces.
Mahadevapura	There are few number of parks. are scattered and has limited access due to industrial growth.	Has low to moderate vegetation, have sparse vegetation in industrial areas and IT hubs.	Has high and extensive built-up areas in industrial hubs.	Has low presence and minimal water bodies in most parts.	Has severe heat stress caused by industrial activity.	Has poor to moderate stressed vegetation, slightly better near IT campuses.	Has low and insufficient tree cover.	Faces significant ecological challenges, slightly better conditions near landscaped IT hubs.
RR Nagar	There are moderate number of parks, better distributed than Dasarahalli and Bommanahalli, but are in smaller size than South Zone parks.	Has moderate to high vegetation. has decent vegetation cover in certain residential pockets.	Has moderate and a mix of built-up areas and open spaces.	Has moderate amount of water body and some water bodies supporting vegetation.	Have lower surface temperatures compared to heavily urbanized zones.	Has moderate to high healthier vegetation in some pockets.	Relatively Higher and better tree cover compared to industrial zones.	Performs better than East Zone due to larger green spaces and moderate ecological balance. Urban growth poses challenges.

Figure 41

4.9 Inferences

Open spaces in Bangalore significantly enhance quality of life by providing physical, mental, and social benefits. These include improved physical health through recreational activities, mental well-being through stress reduction, and social cohesion by fostering community interactions.

Green spaces mitigate urban heat island effects, improve air quality, and contribute to environmental sustainability. However, Bangalore's current provision of 2.2 sq. m of open space per capita is far below global recommendations, negatively impacting residents' well-being.

Rapid urbanization has reduced the city's green cover to just 8.4% of its total area, insufficient for its population of over 12 million.

Environmental degradation due to urbanization has further diminished the cooling and pollution-reducing effects of green spaces.

Key Benefits of Open Spaces:

1. Environmental: Improved air quality, temperature regulation, and biodiversity conservation.

2. Social: Enhanced leisure opportunities, cultural preservation, crime reduction, and social inclusion.

3. Economic: Increased tourism potential, job creation, and reduced healthcare costs due to improved public health.

Open spaces are essential for enhancing the quality of life by improving physical health, mental well-being, social cohesion, and environmental sustainability.

Use of geospatial methods, such as remote sensing and GIS, to examine urban parks and open spaces in Bangalore, highlighting their crucial role in data gathering and thorough assessments of green space distribution, air quality, and microclimates. By employing indices like NDVI (Normalized Difference Vegetation Index), LST (Land Surface Temperature), and VCI (Vegetation Condition Index), the study underscores environmental shifts over the past decade,

including the reduction of water bodies, increased urbanization leading to more built-up areas, and rising land surface temperatures in regions with limited vegetation.

Analysis by zone uncovers disparities in park distribution and conditions: the South Zone boasts dense vegetation and better park access, whereas zones like East, West, Bommanahalli, Dasarahalli, and Mahadevapura struggle with limited green spaces, sparse vegetation, and high built-up areas.

Wards with high population density but limited open space (e.g., Shivajinagar or Majestic areas) face the worst conditions. These areas experience environmental degradation and reduced quality of life due to inadequate green infrastructure.

Wards near peripheral regions or large parks (e.g., Cubbon Park or Lalbagh) fare better in terms of accessibility and environmental benefits.

The carrying capacity indicates that the city's parks and green spaces are overburdened and unable to meet the recreational and environmental needs of its growing population.

The existing parks are overcrowded, poorly maintained, and lack equitable distribution, leading to disparities in access across different wards and zones.

The government should prioritize interventions in RR Nagar Zone, which has the lowest percentage of parks in good condition, and in peripheral zones like Dasarahalli and Mahadevapura to improve the availability and quality of open spaces, ensuring equitable access and enhancing the overall quality of life for residents and in central zone of the city for improving vegetation cover and reducing land surface temperature for the open spaces located there.

5 RECOMMENDATIONS AND PROPOSALS:

5.1 The Green Equity Bangalore Model (GEBM) Proposal

Problem Statement: Decline in Per Capita Open Space, Increasing Urban Heat, and Rising Demand for Quality Public Parks in Bengaluru.

Vision: To create more green spaces across the city and connect people and parks to enhance quality of life.

Benefits of this Model

1. Addresses Observed Gaps:

Your maps show underserved peripheral zones (Mahadevapura, Bommanahalli) and overcrowded central parks. GEBM targets these gaps directly.

Balances equity (new parks in low-access areas) and quality (upgrades in central zones).

2. Leverages BBMP's Ongoing Work:

Aligns with BBMP's ₹25 crore park development budget, tenders, and innovations (e.g., treated water, recharge pits).

Enhances current plans with spatial equity analysis and community co-creation.

3. Scalable & Replicable:

Uses GIS and participatory frameworks applicable to other Indian cities.

Integrates global best practices (e.g., Melbourne's urban forest strategy, Medellín's green corridors).

The Green Equity Bengaluru Model (GEBM) offers a holistic, data-driven framework to transform BBMP's ongoing park development plan into a national benchmark for equitable and sustainable urban green spaces. By addressing spatial inequities, fostering community ownership, and integrating climate resilience, this model ensures Bengaluru's parks become inclusive, vibrant, and future-ready.

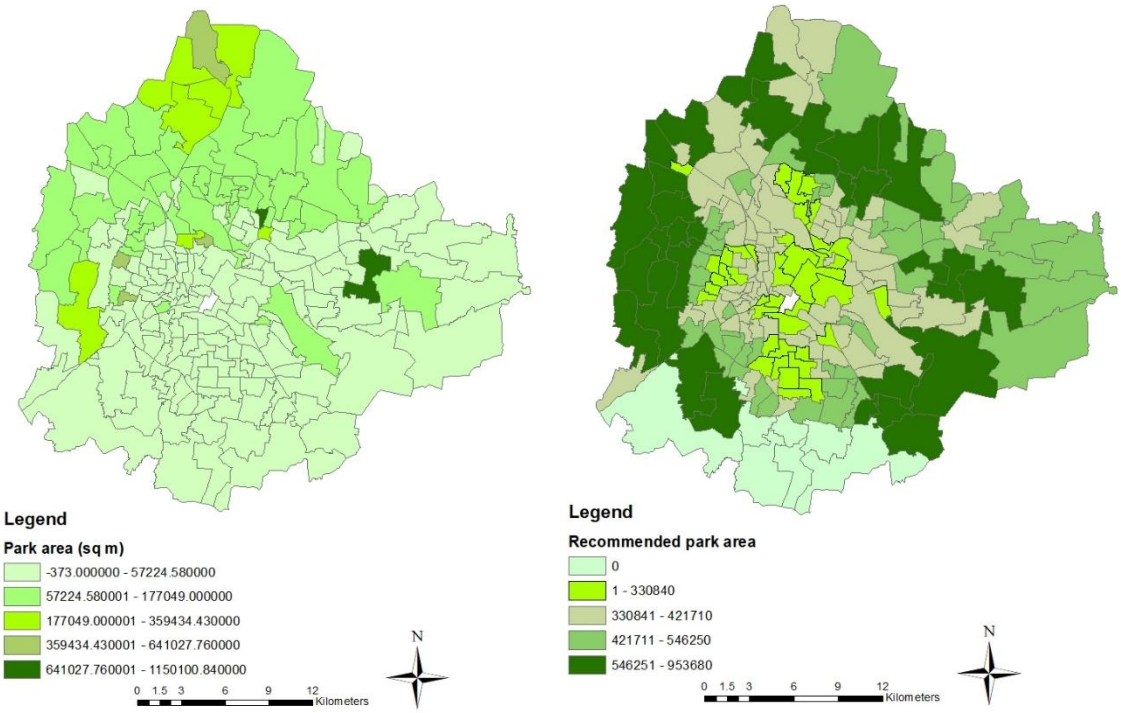


Figure 42

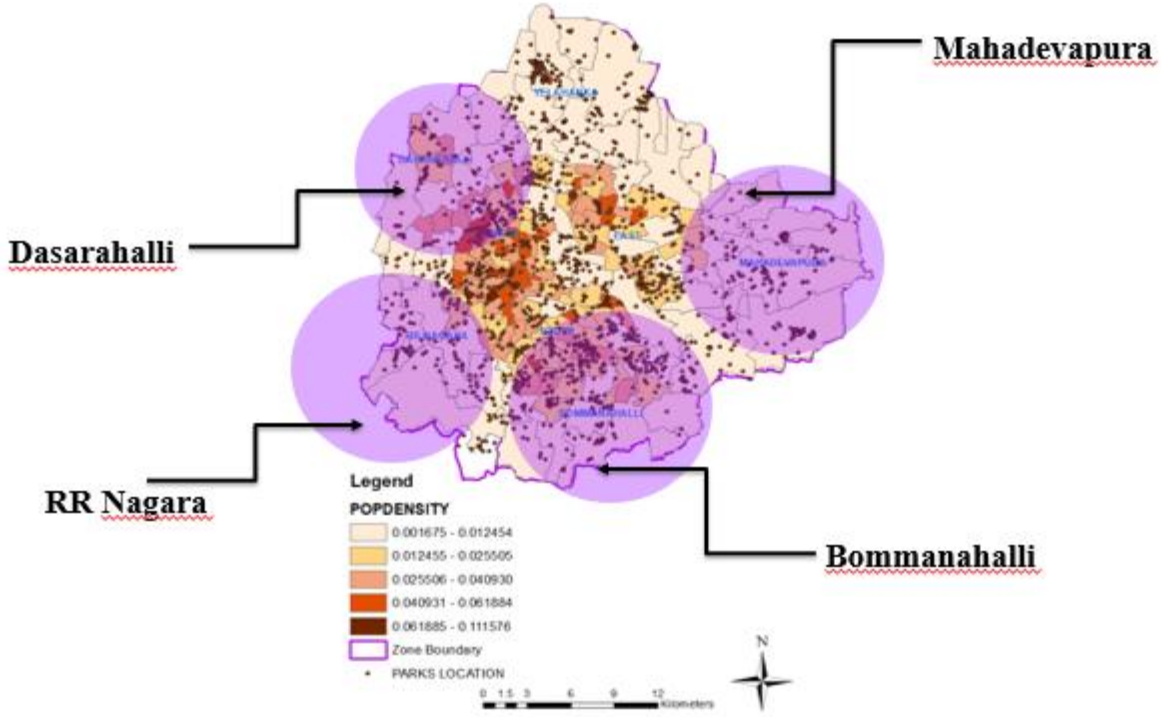


Figure 43

Zone	Pop. Density	Park Density	Status
Central/West	High	High	Overcrowded
East/Southeast	High	Moderate	Some gaps
Mahadevapura	Mod/High	Low	Underserved
Bommanahalli	Mod/High	Low	Underserved
Yelahanka	Low/Moderate	Low	Underserved
Dasarahalli	Low/Moderate	Low	Underserved
RR Nagara	Low/Moderate	Low	Underserved

Table 17

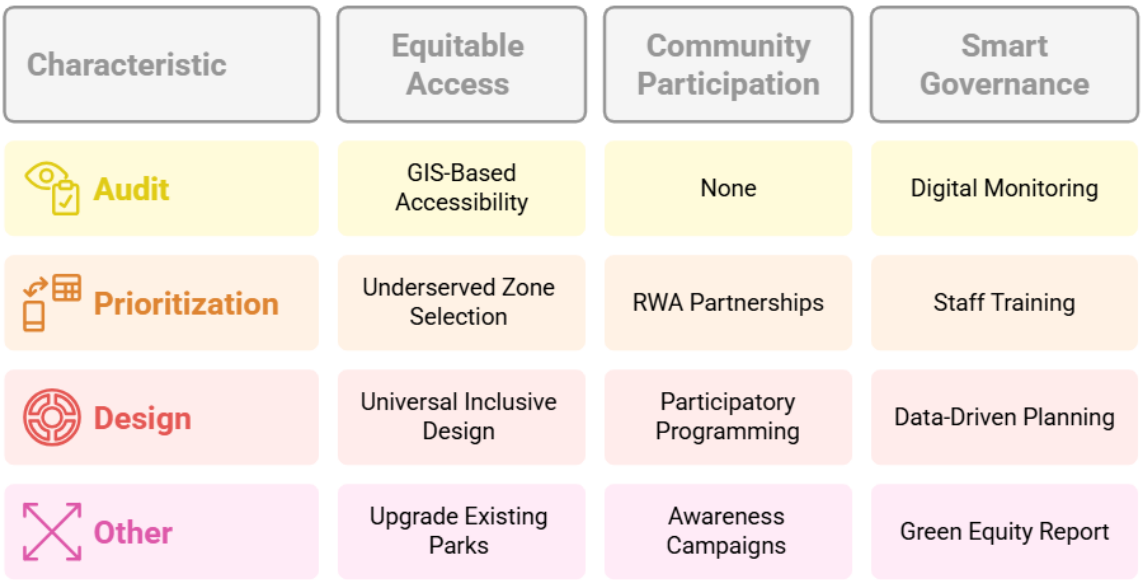


Figure 44

Parameters	How It Improves Quality of Life	Key Strategies	Alignment with BBMP 2025–26 Plan
Equitable Access	Ensures all citizens, including those in underserved and peripheral areas, have walkable access to parks and green spaces. Reduces health disparities, supports physical and mental well-being, and fosters social inclusion.	- Map underserved zones (e.g., Mahadevapura, Yelahanka, Bommanahalli, Dasarahalli) - Prioritize new parks in these areas - Universal design for inclusivity - 400m accessibility buffer for all households	- 14 new parks to be developed, especially in outer zones - Focus on accessibility and inclusion in park upgrades
Community Participation	Builds a sense of ownership, increases park usage, and ensures spaces meet local needs. Strengthens community bonds and social capital.	- RWA and monitoring - Participatory budgeting and design - Cultural and educational programming in parks	- Policy for community involvement in park conservation under development. - Pilot RWA engagement underway.
Smart Governance	Ensures parks are well-maintained, safe, and responsive to citizen feedback. Promotes transparency, accountability, and efficient resource allocation.	- Online park monitoring and complaint tracking - GIS-based gap analysis - Digital dashboards for park management	- Online park monitoring system being implemented. - Tree census to inform future strategy - Digital oversight in progress

Table 18

Phase	Key Actions	Timeline
Short-Term	GIS audit, buffer analysis, RWA engagement, pilot workshops, dashboard launch	0–12 months
Mid-Term	New park construction, universal design roll-out, community programming, staff training	1–3 years
Long-Term	90% walkable access, city-wide RWA partnerships, annual reporting, policy refinement	3–5 years

Table 19

Implementing the Green Equity Bengaluru Model (GEBM) and similar park and greenery-focused proposals will deliver a wide range of environmental, social, health, and economic benefits for Bengaluru.

1. Improved Quality of Life and Public Health

- **Increased access to parks and green spaces** will provide more opportunities for recreation, relaxation, and social interaction, leading to better physical and mental health for all age groups.
- **Reduction in urban heat island effect** and improved microclimate, making neighborhoods cooler and more comfortable, especially during heatwaves.

2. Greater Equity and Inclusivity

- **Equitable distribution of parks** ensures that underserved and peripheral neighborhoods (like Mahadevapura, Bommanahalli, Yelahanka, Dasarahalli, RR Nagara) have walkable access to quality green spaces, reducing disparities in health and well-being.
- **Universal design and community co-creation** make parks accessible and welcoming for people of all ages, genders, and abilities.

3. Environmental Sustainability and Climate Resilience

- **Expansion of greenery and tree cover** helps absorb air pollutants, sequester carbon, and support biodiversity, contributing to a cleaner and more resilient urban environment.
- **Storm water management and groundwater recharge** through features like rain gardens and recharge pits, reducing flood risk and improving water security.

4. Economic and Social Value

- **Higher property values and local business opportunities** near well-designed parks, contributing to economic growth.
- **Job creation** in landscaping, park maintenance, and community programming as part of ongoing greening efforts.
- **Potential to earn green credits and attract investment** through climate-positive actions and alignment with national green credit initiatives.

5. Stronger Community Engagement and Governance

- **Active community participation** (RWAs, NGOs, local businesses) in park management fosters stewardship and a sense of ownership, leading to better-maintained and safer public spaces.
- **Smart governance and data-driven planning** (e.g.online park monitoring, annual green equity reports) ensure transparency, accountability, and continuous improvement.

Figure 45

5.2 Bangalore Landfill Biodiversity Park

Problem Statement: Bengaluru's old landfills like Bellahalli and Mavallipura pose serious environmental and health risks but also offer a chance for renewal. Transforming them into biodiversity parks can restore ecosystems, support urban wildlife, and create much-needed green spaces for all.

Vision: To transform Bengaluru's legacy landfill sites into vibrant, interconnected biodiversity and climate action parks that:

- Restore native habitats and urban ecosystems
- Provide inclusive recreational, educational, and cultural spaces
- Enhance climate resilience through nature-based solutions

Key Strategies

Safety and Scientific Remediation

First and foremost, the landfill must be safely capped using engineered layers that stop leachate and methane gas emissions while closely adhering to CPCB and BBMP regulations. To stabilize the site and progressively restore soil health, phytoremediation using native species that can withstand pollution should be started.

Restoration of Native Habitat

Restoring wetlands, grasslands, and native woodlands must be the main goal of restoration projects. This strategy will help to reverse the loss of biodiversity in Bengaluru's urban landscape by establishing essential habitats for pollinators, birds, and urban animals.

Designing Inclusive Public Spaces

There should be open recreational grounds, boardwalks, accessible walking routes, and outdoor classrooms in the park. Community education and environmental awareness will be promoted by interpretive signage and educational installations.

Participation in the Community and Stewardship

It is essential that locals, schools, and NGOs all actively participate. Long-term stewardship and a strong sense of community ownership will be ensured by initiatives including plantation drives, citizen science programs, and "Friends of the Park" groups.

Continuous Monitoring

Installing environmental sensors for soil, water, and air quality and releasing data often will help to foster public trust and direct adaptive management.

Alignment of Policies and Collaborations

To guarantee long-term sustainability and regulatory compliance, all plans must be in line with BBMP's mandates for waste management, urban greening, and public health. They should also entail cooperation with local organizations, academic institutions, and government agencies.

Parameter	Action to be Taken	Responsible Parties
Landfill Remediation	Cap landfill with engineered layers, install methane vents, manage leachate	BBMP Engineering, Solid Waste Management, Contractors
Native Habitat Restoration	Reforest with native trees, create grasslands, wetlands, butterfly gardens	BBMP Horticulture, Forest Cell, Local Volunteers
Infrastructure Development	Construct walking trails, boardwalks, observation towers, play areas	BBMP Parks, Civil Engineering, Architects
Community Engagement	Organize plantation drives, citizen participation, awareness programs	BBMP Horticulture, Education Dept, NGOs, Schools
Event Programming	Host nature walks, festivals, yoga, art and cultural events	BBMP Parks, Local Groups, NGOs
Environmental Monitoring	Install sensors for air, water, and soil quality; regular data collection and sharing	BBMP Environment, Academic Partners
Park Management & Stewardship	Establish maintenance teams, Involve Locals,	BBMP Parks, Ward Committees, Community Leaders

Table 20

Figure 46

Term	Key Activities
Short-Term	- Site assessment and baseline surveys (soil, water, air, biodiversity) - Stakeholder consultations and master plan preparation - Landfill capping, containment, and installation of methane/leachate management systems - Initiate phytoremediation with pollution-tolerant native species - Initial community engagement and awareness campaigns
Medium-Term	- Large-scale native tree plantation and creation of grasslands, wetlands, and butterfly gardens - Development of water management features (bioswales, ponds) - Construction of walking/cycling trails, boardwalks, observation towers, recreational lawns, play areas, amphitheater, and educational signage - Expand community programs (citizen science, eco-education, regular cultural/wellness events)
Long-Term	- Continuous environmental monitoring (air, water, soil) and adaptive management - Routine park maintenance and stewardship - Ongoing community engagement and feedback - Periodic review of ecological and social outcomes to ensure sustainability and resilience

Table 21

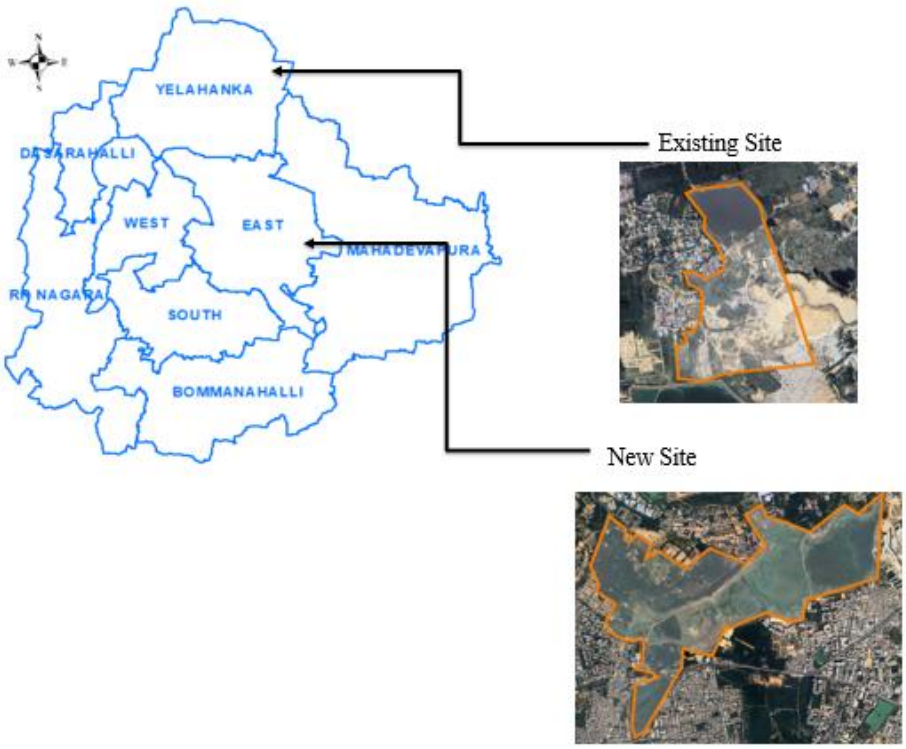


Figure 47

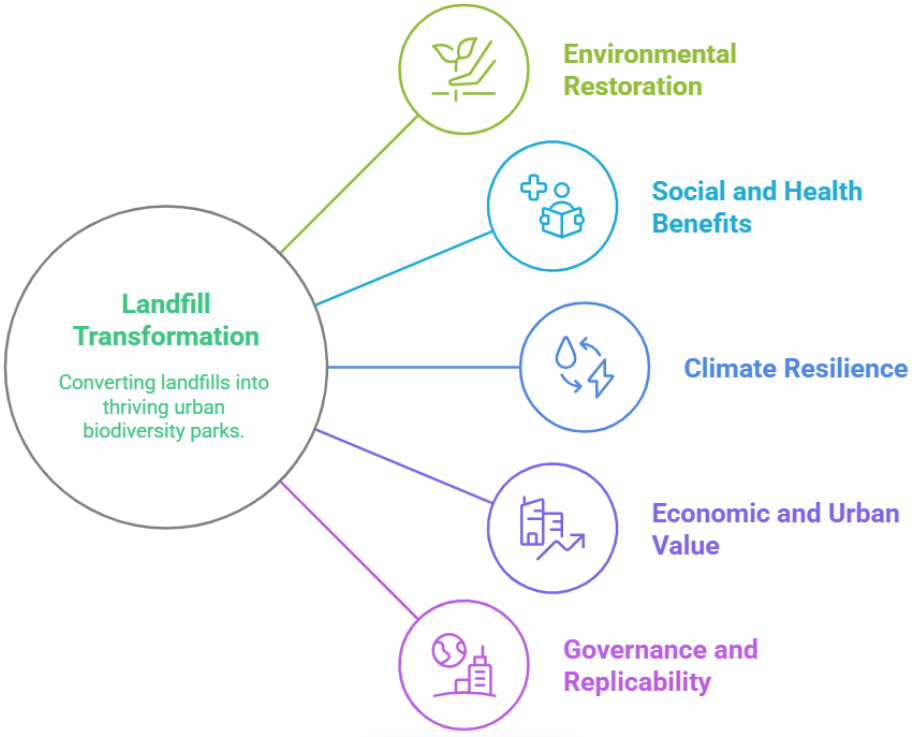


Figure 48

5.3 Parks as Biodiversity and Climate Action Zones

Problem Statement: Rapid urbanization, the loss of native green cover, and deteriorating ecological networks are all contributing to Bengaluru's increasing urban heat, frequent flooding, and degradation in urban biodiversity. Parks urgently need to be considered as multipurpose areas that support biodiversity conservation and climate adaption in addition to offering recreational opportunities.

Vision: To turn Bengaluru's parks into interconnected areas for climate action and biodiversity that:

- Restore and protect natural environments
- Enhance climate resilience through nature-based solutions
- Involve the public in environmental monitoring and stewardship

Key Strategies

1. **Habitat Restoration & Pollinator Gardens**

Replace exotic plantings with native trees, shrubs, and grasses.

Establish pollinator gardens with flowering plants to support bees, butterflies, and birds.

Restore wetland features in parks where feasible.

2. **Sustainable Park Operations**

Install rainwater harvesting systems to manage storm water and recharge groundwater.

Reduce your carbon impact by installing solar panels for park amenities and lights.

Use permeable pathways and rain gardens to minimize runoff and urban flooding.

3. **Citizen Engagement & Biodiversity Monitoring**

Organize citizen-led tree planting drives and biodiversity mapping events.

Install smartphone apps and digital dashboards to track the health of trees and report wildlife observations.

Run educational workshops on urban ecology and climate adaptation.

4. **Ecological Connectivity**

Link parks via green corridors (e.g., along drains, roadsides) to create wildlife movement pathways.

Prioritize connectivity in underserved zones to maximize ecological and social impact.

Habitat Restoration
Restore natural habitats for local wildlife
Sustainable Operations
Implement eco-friendly practices within park operations
Citizen Engagement
Involve citizens in ecological monitoring activities
Ecological Connectivity
Connect parks through green spaces and corridors

Figure 49

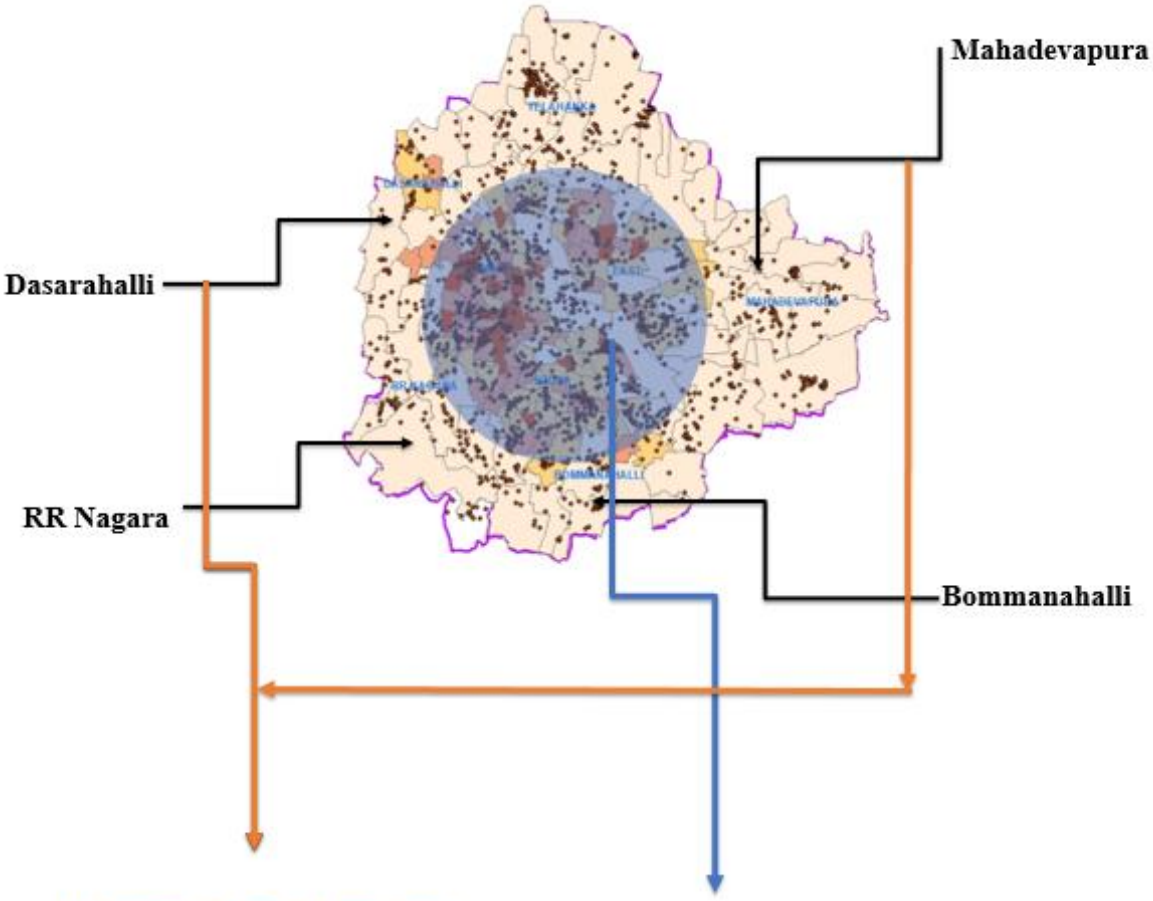

Mahadevapura
Dasarahalli
RR Nagara
Bommanahalli
• Underserved in park density and ecological services.
• These zones have lower park density, higher vulnerability to urban heat and flooding, and greater need for ecosystem restoration.
• Central, West, East and Southeast
• Overcrowded or moderate gaps.
• Focus on upgrading existing parks for biodiversity and climate resilience, but prioritize new interventions in underserved zones.

Figure 50

Phase	Key Actions	Responsible Parties	Alignment with BBMP 2025–26 Plan
Site Selection & Baseline Assessment	- GIS mapping to identify parks in underserved zones - Field surveys to assess biodiversity, soil, water, and microclimate conditions.	BBMP, GIS experts, environmental NGOs	Supports equitable access by prioritizing underserved zones.
Stakeholder Engagement	- Participatory workshops with RWAs, schools, and citizen groups. - Collaborate with NGOs for co-designing interventions.	BBMP, RWAs, NGOs, academic institutions	Aligns with community participation goals and smart governance.
Pilot Projects	- Launch 1–2 demonstration parks per priority zone. - Test gardens, rainwater harvesting, and native habitat restoration.	BBMP, NGOs, local communities	Pilots align with the "14 new parks" target and climate resilience objectives.
Scaling Up	- Expand successful models to all parks in underserved zones. - Develop green corridors along drains/roads to connect parks.	BBMP, urban planners, environmental agencies	Supports ecological connectivity and city-wide green infrastructure.
Monitoring & Adaptive Management	- Deploy digital dashboards and apps for real-time biodiversity tracking. - Annual audits and adaptive strategies based on feedback.	BBMP, tech partners, citizen scientists	Integrates with BBMP's digital monitoring systems and smart governance framework.

Table 22

Phase	Key Actions	Timeline
Short-Term	GIS mapping of biodiversity gaps, pilot pollinator gardens, RWA engagement	0–12 months
Mid-Term	Large-scale habitat restoration, rainwater harvesting and solar installations, citizen science programs	1–3 years
Long-Term	City-wide ecological network, policy integration, annual biodiversity audits	3–5 years

Table 23

Expected Outcomes

- Increased Urban Biodiversity: More native species, pollinators, and urban wildlife.
- Climate Resilience: Reduced urban heat, improved storm water management, and groundwater recharge.
- Community Engagement: Higher citizen participation in stewardship and environmental monitoring.
- Equitable Access: Underserved zones benefit from improved ecological services and green infrastructure.
- Policy Impact: Model for city-wide integration of biodiversity and climate action into park management.

Alignment with BBMP 2025–26 Plan

- Supports: Equitable access, environmental sustainability, smart governance, and community participation.
- Leverages: Ongoing initiatives for new park development, digital monitoring, and RWA engagement.

A multifaceted answer to Bengaluru's urgent environmental and social problems is provided by the plan to turn the city's parks into biodiversity and climate action zones. For Bengaluru to have a sustainable future, park planning and management must incorporate biodiversity and climate action. By acting as community gathering places, educational opportunities, and natural havens, biodiversity parks improve ecological health and urban resilience.

5.4 Recommendations and Future Scope

According to the study's overall findings, Bangalore's open space availability is woefully insufficient and unequally distributed, with each person having access to just 2.2 square meters of park space, which is much less than both national and international norms. In the city's outlying and quickly urbanizing areas, where certain wards have no planned parks at all, this deficit is especially severe. The study, which made use of remote sensing, GIS mapping, and spatial analysis, shows how this shortfall has resulted in congested and badly maintained parks, worsening urban heat island effects, declining air quality, and less chances for social contact and enjoyment. These problems have been made worse by the city's fast growth and lack of open space, particularly for underprivileged groups and those residing on the periphery. The results of the study highlight how urgently open space development needs to be approached strategically, fairly, and sustainably, giving social inclusion and environmental resilience top priority.

Bangalore's open space development has a wide-ranging and diverse future that presents chances for creativity in community involvement, environmental management, and urban planning. Using cutting-edge technology like remote sensing, GIS, based sensors to monitor park usage, air quality, biodiversity, and maintenance requirements in real-time is one exciting avenue. By using data to guide adaptive management and policy choices, parks can continue to adapt to shifting urban dynamics and climatic conditions. To improve storm water management, groundwater recharge, and urban cooling, particularly in flood-prone and heat-affected areas, blue-green infrastructure such as rain gardens, and artificial wetlands should be expanded within parks and along biological corridors.

Additionally, there is a great deal of opportunity for co-management and participatory planning approaches, which would enable NGOs, schools, resident welfare associations, and local communities to actively participate in park programming, design, and stewardship. Residents of all ages can develop a sense of ownership and environmental literacy by implementing citizen science projects for biodiversity monitoring and environmental education. The future scope of the policy includes promoting anti-encroachment measures, the integration of open space policies into larger urban resilience and climate adaption plans, and the rigorous enforcement and periodic revision of land reservation norms.

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